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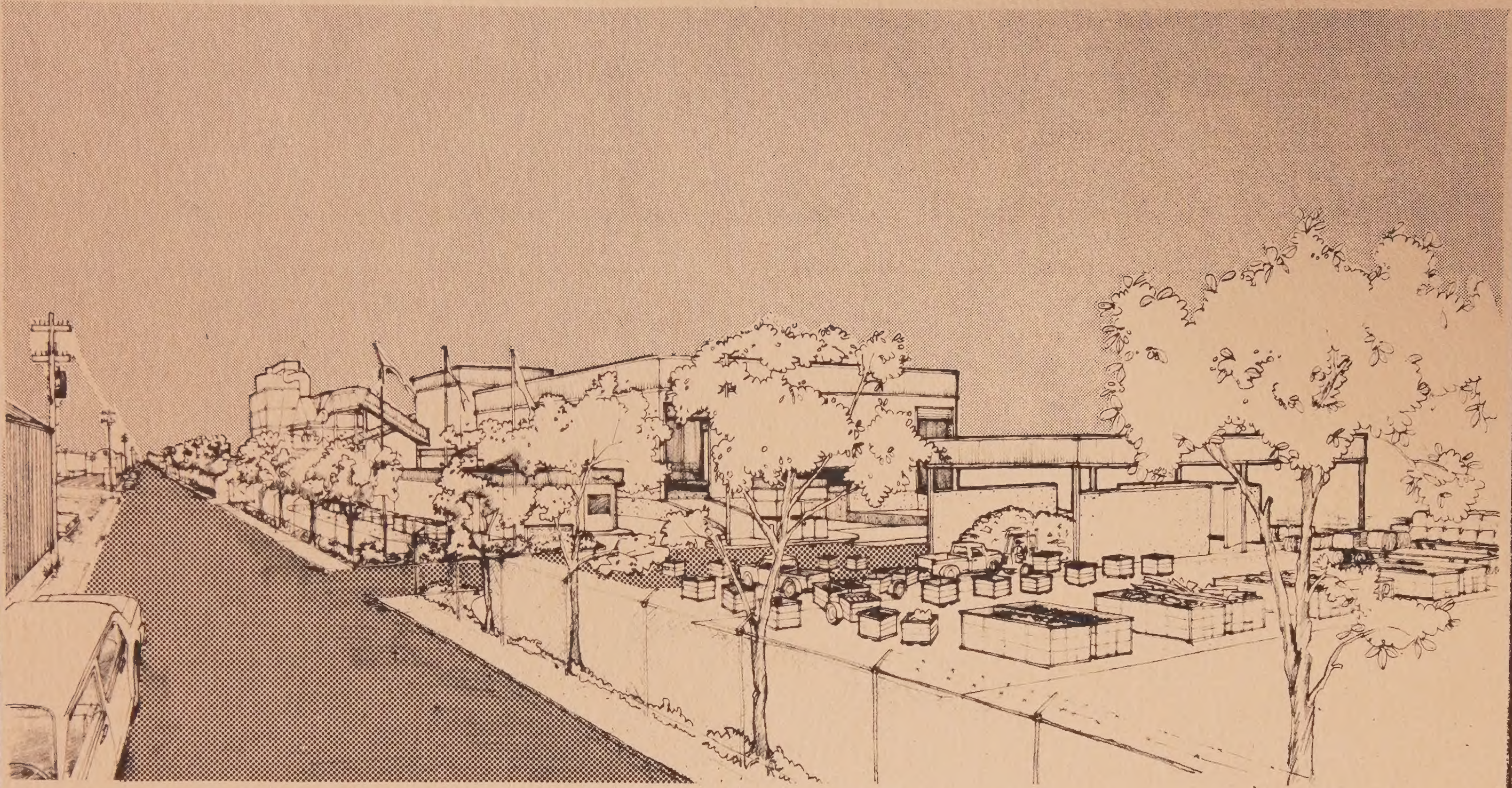
Civic Center Building
2180 Milvia Street
Berkeley, Calif. 94704

SOLID WASTE MANAGEMENT CENTER

PHASE TWO - SEPTEMBER 1978



CITY OF BERKELEY

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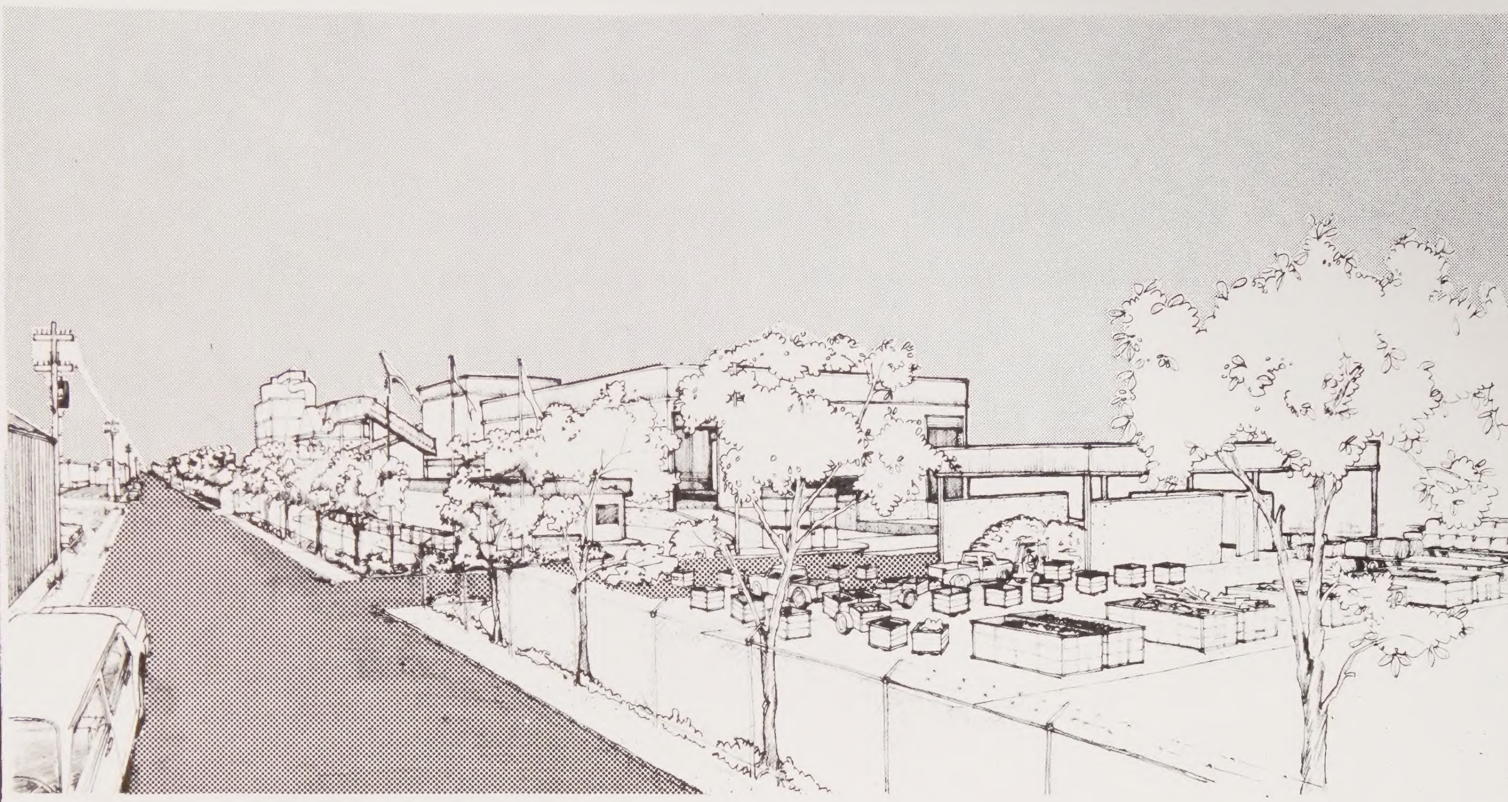
SOLID WASTE MANAGEMENT CENTER

PHASE TWO - SEPTEMBER 1978



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ACKNOWLEDGMENTS

The authors would like to thank Mr. Roy E. Oakes, Director of Public Works, his staff, the Solid Waste Management Commission, and the State Solid Waste Management Board, for their guidance and assistance throughout this project. We would also like to express our appreciation to Mr. Terry Harrison for his contributions. Finally, we would like to acknowledge the cooperation of the Berkeley-Albany Industries Association and the many industrial representatives who provided us with data through the course of our study.

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CHAPTER 1

PROJECT SYNOPSIS

1A INTRODUCTION

1A.1 Project Evolution

The City of Berkeley is one of the few municipalities in the San Francisco Bay Area where refuse is collected by municipal crews and disposed of on land owned by the City. The disposal site is located at the Berkeley Marina and is operated by a private franchisee, Berkeley Landfill Company. It is estimated that the presently diked area will reach capacity by 1982.

Earth Day, 1969, gave birth to the City's first recycling center. Since that time, a number of other recycling and waste reduction programs have been implemented in Berkeley:

- A second recycling center.
- A monthly residential, curbside, newspaper pickup program.
- A monthly subscription pickup program for glass, cans, and newspapers.
- A wine bottle washing project.
- A plant debris composting project.
- An ordinance requiring a deposit on beverage containers enacted by the City Council and pending in the Courts.

Anticipating the necessity for an alternative and more environmentally sound solid waste management system, the City Council established a Solid Waste Management Commission in 1972. The Commission was mandated to develop a short-term plan for reducing the quantity of solid waste generated and a long-term ecologically sound plan for managing the City's refuse in the future.

In 1973, in response to a recommendation by the Solid Waste Management Commission, the City Council decided to purchase a site for a solid waste transfer station. Shortly thereafter, two parcels of land were purchased on Second Street bounded by Gilman and Harrison Streets. An option on a third intermediate parcel was also obtained. The total proposed site encompasses 6.3 acres.

The City Council commissioned Peter Chiu and Luis Diaz in 1975 to assemble data on refuse generation and disposal in Berkeley and study the relationship of Berkeley's resource recovery alternatives to suggested regional plans. This report recommended that the transfer station incorporate recovery processes to ensure the maximum reutilization of resources.

In 1976, the Commission prepared a source separation and waste reduction plan (Reference 2). The Commission recommended to the Council that curbside collection of source grouped materials be implemented and that space be allocated at the proposed transfer station site to incorporate a storage depot for collected materials and a public recycling center.

Concurrent with the development of the Commission's plan, the future utilization of a proposed seven acre tract of the Marina landfill site became questionable due to action taken by the Corps of Engineers and the Regional Water Quality Control Board. Faced with the possibility of early closure of the landfill, the City Council approved a recommendation by the Public Works Department to contract with consultants for preliminary engineering of a Solid Waste Management Center (SWMC) at the Gilman Street site. Proposals were requested and the firm of Garretson•Elmendorf•Zinov•Reibin, Architects and Engineers, of San Francisco, California (G•E•Z•R) was selected to provide the preliminary engineering. Spectrum Northwest, Social and Environmental Planning Consultants, of San Francisco, was commissioned to prepare a corresponding environmental impact study.

In June, 1978, G•E•Z•R published SOLID WASTE MANAGEMENT CENTER - PHASE ONE. A second phase of study funded by the State Solid Waste Management Board, was sparked by the interest of local industry in utilizing energy produced from refuse at the SWMC. The energy recovery study identifies and recommends appropriate scale resource recovery systems. This report presents the work undertaken during this part. Phase Three will provide the preliminary engineering to incorporate the system recommended in Phase Two into the SWMC. Phase Three has not yet been funded.

1A.2 Scope of Work

1A.2.1 Goals and Objectives

The goals and objectives of the City and the State Solid Waste Management Board for Phase Two are as follows:

- To identify appropriately scaled systems to recover resources and energy from the waste stream.
- To examine the technical reliability, environmental acceptability, energy productivity, and economic attractiveness of resource recovery units.
- To evaluate the compatibility of resource recovery systems with a city-wide source separation program.

1A.2.1 (Continued)

- To propose fur further consideration system(s) which would provide the City with a technically reliable, environmentally responsible and economically attractive method for recovering resources from solid wastes.

1A.2.2 Methodology of System Analysis

Appropriately scaled systems that offer the flexibility of modular development will be identified. Each will undergo a preliminary evaluation as specified in the work-plan (Appendix B) with respect to:

- Marketability of end-products
- Degree of system demonstration
- Technical reliability
- Equipment durability
- Environmental ramifications
- Net energy production effectiveness
- Cost effectiveness.

Cost estimates were developed from manufacturers' data and previously published reports. No preliminary design has been conducted by the consultants during the course of this report. Therefore, a twenty (20) percent contingency was added to manufacturers' estimates to cover site specific conditions.

1A.2.3 Report Presentation

This report is presented in six chapters. Chapters are defined as follows:

- Chapter 1 - PROJECT SYNOPSIS - sets project direction and summarizes major project findings and recommendations.
- Chapter 2 - DESIGN PARAMETERS - establishes the data base for the study.
- Chapter 3 - DISPOSAL ALTERNATIVES - identifies disposal alternatives available to the City and establishes base line cost data from which to evaluate the economic attractiveness of resource recovery alternatives.

- Chapter 4 - RESOURCE RECOVERY ALTERNATIVES - identifies resource recovery alternatives and considers their technical reliability, potential environmental impacts, and energy productivity.

- Chapter 5 - ECONOMIC ANALYSIS - establishes economic data on resource recovery systems identified. Comparisons are made against the least cost non-recovery alternative.

- Chapter 6 - RECOMMENDATIONS - presents project recommendations.

1B SUMMARY OF ALTERNATIVES CONSIDERED

Resource recovery alternatives and existing disposal alternatives for unprocessed solid wastes identified for evaluation in this study are ranked below in order of least cost per incoming ton. This indicator was utilized as it most nearly parallels the increased disposal costs to be borne by Berkeley citizens. Resource recovery alternatives are described in Chapter Four. Economic evaluations are presented in Chapter Five. All costs in this report are in mid-1978 dollars and do not include the cost of collection. Annual 1978 tonnage is estimated at 64,000.

System	Net Cost Per Ton ($)	Annual Net Cost ($)	Capital Cost ($)
1. Package Incinerators	$ 9	$ 585,000	$ 6,600,000
2. Transfer/Haul and Disposal at Acme Fill Company's Landfill	$20	$1,317,000	$ 2,509,000*a
3. Transfer/Haul and Disposal at Vasco Road Landfill	$21	$1,399,000	$ 2,589,000*a
4. RDF Production	$21	$1,370,000	$ 6,600,000
5. Direct Haul to Acme Fill Company's Landfill	$29	$1,127,000	$ 1,380,000*a
6. BSP Pyrolyser	$30	$1,946,000	$12,000,000
7. Waterwall Combustion (Unprocessed)	$30	$1,956,000	$16,500,000
8. Andco-Torrax	$35	$2,241,000	$18,200,000

*a Reference 1 - Capital costs obtained from Appendix C and Tables 5-3 and 6-1 (Capital costs associated with haul have been subtracted from Tables 5-3 and 6-1).

1B (Continued)

	System	Net Cost Per Ton ($)	Annual Net Cost ($)	Capital Cost ($)
9.	Direct Haul to Vasco Road Landfill*b	$38	$1,472,250	$ 1,440,000*a
10.	Waterwall Combustion (RDF)	$41	$2,626,000	$16,500,000
11.	Waterwall Combustion (Shredded)	$43	$2,766,000	$18,600,000

*a Reference 1 - Capital costs obtained from Appendix C and Tables 5-3 and 6-1 (Capital costs associated with haul have been subtracted from Tables 5-3 and 6-1).

*b Based only on those tons currently collected by City Crews, 39,000 tons per year; citizens and private collectors would be responsible for transporting the remaining tonnage (25,400) at their own expense.

1C SUMMARY OF PROJECT FINDINGS AND RECOMMENDATIONS

1C.1 Findings

- The least costly resource recovery alternative considered is Package Incineration producing steam.

- There are currently twelve (12) package incinerator facilities processing mixed municipal waste (MSW) in the United States, three (3) of which generate steam.

- Based on recent improvements in equipment, the redundancy of modular components, and the operating experience of existing facilities, Package Incineration can be considered a reliable technology.

- Two currently unanswered environmental questions remain which are common to all the resource recovery systems evaluated (indirectly with respect to RDF Production Systems) - the extent of air pollution and classification of residuals (bottom and fly ash). The analysis being conducted by the Environmental Protection Agency (EPA) and the State Solid Waste Management Board on the Package Incinerator facility in North Little Rock, Arkansas, is expected to supply required data to resolve these issues. There are no other unmitigable environmental impacts with this system.

- Package Incineration ranks third in terms of energy productivity (i.e., the ratio of initial energy value of refuse less system energy requirements and heat losses divided by initial energy value of refuse), at fifty-four (54) percent. Waterwall Combustion of unprocessed refuse has the highest productivity at sixty (60) percent.

- Twelve (12) entities (private firms and public institutions) have expressed interest in purchasing refuse derived steam produced from a Berkeley facility.

- A Package Incinerator System is compatible with on-site recovery of ferrous materials. This could be accomplished by the inclusion of preprocessing steps such as trommeling and magnetic ferrous removal. However, if recovery of significant quantities of glass and aluminum is to be part of the City's resource recovery program, a source separation system incorporating Curbside Collection and a City-wide Recycling Center is required. A further advantage of a source separation program is that paper products are recycled into new products, rather than burned for its energy value. This permits significant environmental benefits. Based on the costs of these programs reported in the Phase One Study and the effects of removing combustibles from the waste stream prior to incineration, operating a parallel source separation program is expected to increase net costs by $284,000 or $4 per incoming ton of refuse to the SWMC. City costs could be reduced through capital and/or operating subsidies (CETA, SB 650, etc.).

1C.1 (Continued)

- Of the existing disposal alternatives considered for unprocessed refuse, transfer and haul to Acme Fill Company's landfill in Martinez is the least costly.
- The only potential environmental impacts associated with a transfer and haul operation that may be of significance are:

  1) traffic congestion at the SWMC and the residential road leading to the landfill; and

  2) litter at the SWMC.

- The results of the industrial waste survey conducted during the course of this study indicate that approximately 85,400 tons are generated annually from Berkeley industry. An estimated 24,400 tons that are currently being disposed at sites other than the Berkeley Landfill are suitable for processing at the SWMC. Of this tonnage, 3,500 tons are suitable for recycling through source separation techniques. Approximately 41,300 tons of hazardous wastes are generated.
- There are approximately 100,000 tons of processible waste generated annually by neighboring communities (North Oakland, Piedmont, Albany, Emeryville) in Alameda County that are potentially available to Berkeley for resource recovery at the SWMC.

1C.2 Recommendations

- The City should pursue development of a Package Incinerator System producing steam. Consideration should be given to some pre-processing of the refuse to improve combustion, reduce supplemental fuel requirements and ash production, and recover ferrous cans.
- Development should follow the Phase Three workplan as presented in Appendix C. The workplan includes:
  - Confirmation of markets for recovered materials and energy;
  - Identification of regulatory agency requirements and environmental constraints;
  - Preparation of preliminary design and budget cost estimates for the Package Incinerator Plant;
  - Development of financing and institutional arrangements;
  - Establishment of an Implementation Masterplan;
  - Preparation of Request for Proposals Documents and evaluation criteria for private industry;

CHAPTER 2

DESIGN PARAMETERS

2A TYPES, QUANTITIES, AND COMPOSITION OF REFUSE

In this study, emphasis is placed on identifying the quantities and types of wastes that are available for on-site conversion or delivery to offsite customers as a refuse derived fuel. Consequently, the minimum as well as the maximum quantities of waste that could be received at the transfer station are considered depending on whether the City opts to pursue source separation.

The types, quantities, and composition of refuse to be handled at the transfer/processing facility as reported in the Phase One Study are presented in Table 2-1.

The minimum tonnage is defined as tonnage received if source separation occurs.* The maximum tonnage is defined as the tonnage received if no prior source separation occurs. The difference between the maximum and minimum (approximately 9,000 tons) represents the quantity of recyclable material projected to be recovered if source separation is pursued by the City.

2B EFFECTS OF WASTE REDUCTION MEASURES

The tonnages of glass and cans in Table 2-1 are adjusted to reflect implementation of Berkeley's beverage container ordinance. If a Recycling Center is established at the Solid Waste Management Center, waste oil would be accepted from the public at the rate of an estimated 115 tons/year. This estimate includes an expected increase in waste oil recycling as a result of the California Solid Waste Management Board's activities to establish and promote a state-wide waste oil recycling program.

Implementation of the beverage container ordinance, waste oil recycling, and/or source separation will certainly increase public awareness about recycling and promote waste reduction. The degree to which this will reduce the quantity of wastes received at the Transfer/Processing Station is unknown, however the minimum tonnages presented in Table 2-1 should provide an adequate margin of safety for purposes of this analysis.

2C INDUSTRIAL WASTE SURVEY

A mail survey was conducted to establish types and quantities of industrial waste generated in Berkeley that are suitable for processing at the SWMC. Details of survey methodology, mailing list, and questionnaire are presented in Appendix D.

The results of the survey indicate that approximately 85,400 tons are generated annually. The composition of this tonnage is presented in Table 2-2. An estimated 24,400 tons that are currently being dis-

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* Source separation incorporates curbside collection at an assumed participation rate of sixty (60) percent residential and fifty (50) percent commercial, a City-wide Recycling Center, and Storage Depot.

TABLE 2-1

COMPOSITION OF REFUSE TO BE HANDLED/PROCESSED
AT THE SOLID WASTE TRANSFER STATION, 1978

	ANNUAL QUANTITIES					
	(1) Without Any Prior Source Separation		(2) Source Separable With Recycling Center and Curbside Collection		(3) With Prior Source Separation Activities (1) - (2)	
	Tons	Percent	Tons	Percent	Tons	Percent
Paper						
• Newspaper	5,100	8	3,200	34	1,900	4
• Cardboard	4,200	6	2,055	22	2,145	4
• Mixed Paper	9,000	14	715	7	8,285	15
Metal						
• Cans*a	3,200	5	785	8	2,415	4
• Others	1,200	2	0	0	1,200	2
Plant Debris*b	6,700	10	0	0	6,700	12
Glass	5,000	8	2,365	25	2,635	5
Miscellaneous*c	30,000	47	415	4	29,585	54
TOTALS	64,400	100	9,535	100	54,865	100

*a Ten percent assumed aluminum.

*b Does not include plant debris utilized in composting project.

*c Includes food wastes, textiles, plastics, wood, rubber, waste oil, rock, and ash.

TABLE 2-2

INDUSTRIAL/HAZARDOUS WASTES GENERATED IN BERKELEY

	Annual Tons
•Disposed at Berkeley Landfill	
Material Suitable for Processing at SWMC*a	1,100
Material Not Suitable for Processing at SWMC*b	16,800
•Disposed at Richmond and Other Class II or II-1 Bay Area Landfills	
Material Suitable for Processing at SWMC	24,400
Material Not Suitable for Processing at SWMC	1,800
•Disposed at Class I (Hazardous Waste) Sites	41,300
TOTAL	85,400
•Currently Recycled*b	1,000
•Potentially Recyclable	3,500

*a Primarily paper and wood products.

*b Non-suitable wastes include gypsum mud, casting sand, metal slag, and other such materials.

*c This quantity is not included in total generated.

posed at sites other than the Berkeley Landfill are suitable for processing at the SWMC. Of this tonnage, 3,500 tons are suitable for recycling through source separation techniques. Approximately 41,300 tons of hazardous wastes are generated.

2D PROCESSIBLE WASTES FROM NEIGHBORING COMMUNITIES

There are approximately 100,000 tons of processible waste generated annually be neighboring communities in Alameda County* that are potentially available to Berkeley for resource recovery and/or processing at the transfer station. This tonnage is based on information from the Alameda County Solid Waste Management Plan and conversations with Oakland Scavenger Company personnel.

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* These communities include Emeryville, Piedmont, North Oakland, and Albany.

CHAPTER 3

DISPOSAL ALTERNATIVES

3A INTRODUCTION

To analyze the economic feasibility of various resource recovery systems, it is necessary to identify the disposal (as opposed to recovery) alternatives available to the City. In this Chapter, disposal alternatives for unprocessed refuse are presented. Distance and travel time from the SWMC at Second and Gilman Streets are established (refer to Figure 3-1). In the following section, costs are developed for each. The most economical of the alternatives is then evaluated with respect to its energy requirements and environmental impacts.

The disposal alternatives identified for Berkeley's unprocessed refuse are as follows:

3B ALTERNATIVES CURRENTLY AVAILABLE

3B.1 Acme Fill Company's Landfill

This landfill is located in Contra Costa County off Highway 4 and has an estimated lifetime of 30 years at the present rate of filling. Contra Costa Sanitary District is proposing utilization of refuse-derived fuel (RDF) to be co-combusted with sewage sludge for generation of electricity. One possible location for the RDF processing plant is the Acme Fill Landfill. Acme Fill Company's consultants have indicated interest in receiving unprocessed refuse from Berkeley as a feedstock for their proposed RDF Plant.

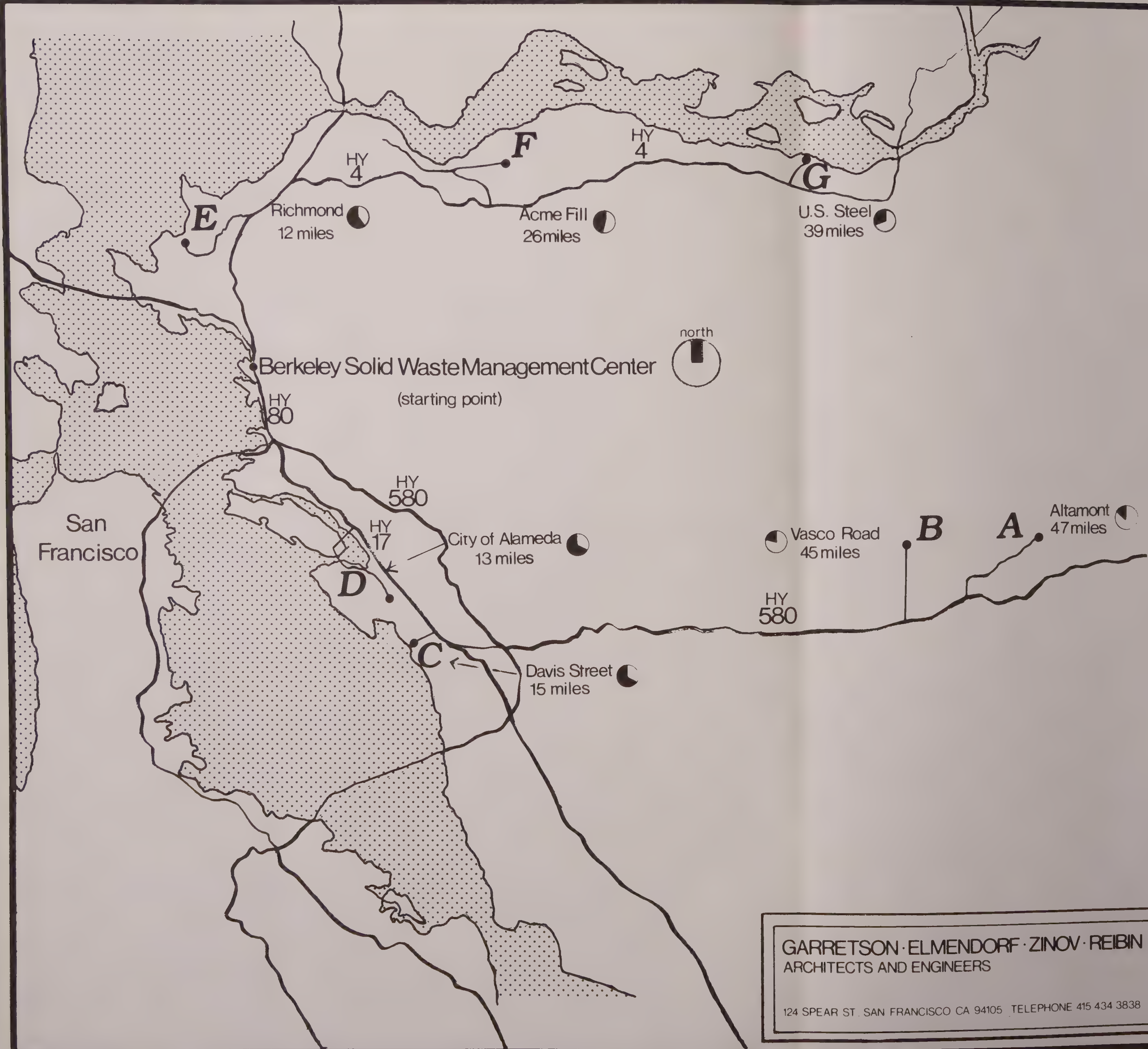
3B.2 Vasco Road Landfill

This landfill is located in Eastern Alameda County off Highway 580 and has an estimated lifetime of 80 or 90 years at present rate of filling. The landfill owners have indicated a willingness to accept Berkeley's refuse.

3C ALTERNATIVES CURRENTLY BEING STUDIED AND POTENTIALLY AVAILABLE IN THE FUTURE

3C.1 Altamont Pass Landfill

A landfill is proposed by the Oakland Scavenger Company for Western Alameda County off Highway 580. This landfill has an estimated design lifetime of at least 60 years. The State Solid Waste Management Board has approved a facilities permit for this landfill.



Location	Route	Exit
A	80 TO 580	GREENVILLE ROAD
B	80 TO 580	VASCO ROAD (NORTH)
C	80 TO 17	DAVIS STREET
D	80 TO 17	HIGH STREET
E	80	EL PORTAL
F	80 TO 4	PACHECO BOULEVARD
G	80 TO 4	LOVERIDGE ROAD

	Key
HY 80	DESIGNATES HIGHWAY NUMBER
	DESIGNATES EXIT AND ROUTE TO DUMP
	TRAVEL TIME (IN MINUTES)

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LOCATION OF
DISPOSAL ALTERNATIVES

FIGURE 3·1

3C.2 City of Alameda Resource Recovery Facility

The City of Alameda is planning a 1,000 ton-per-day (TPD) facility to convert refuse to electrical energy. The City has indicated interest in receiving Berkeley's wastes in either a processed or unprocessed condition. Because traffic congestion is a major concern, they have indicated wastes must be delivered by long haul transport vehicles. For purposes of transportation analyses to follow, it is assumed that the proposed facility would be located at the Alameda City landfill on Bay Farm Island.

3C.3 Davis Street Transfer Station

Oakland Scavenger Company is considering establishment of a transfer station at the present Davis Street landfill located in San Leandro off Highway 17. The proposed transfer station will replace the Davis Street landfill which is scheduled to close shortly. As currently proposed, waste received at the transfer station would be hauled to the Altamont landfill for disposal. Direct haul to this facility is an alternative; however, long haul/transfer is not considered because the cost of transferring Berkeley's waste a second time at the Davis Street transfer station would be prohibitively expensive.

3C.4 North Alameda County Transfer Station

The County Planning Agency is currently considering the location of a number of transfer stations in the county, one of which is to be located in the northern part encompassing Berkeley, North Oakland, Albany, Piedmont, and Emeryville.* For purposes of this analysis, it is assumed that such a facility would be within ten (10) miles of Berkeley.

3C.5 U. S. Steel, Pittsburgh Resource Recovery Facility

U. S. Steel is considering the construction of a 700 TPD refuse-to-steam conversion facility. Planning for this project is not far enough along to determine their interest in Berkeley's refuse.

3C.6 West Contra Costa County Resource Recovery Facility

A preliminary feasibility study for an energy generation facility for West Contra Costa County is in progress. Specifics about the facility will not be available until the study is complete. It is assumed that the facility would be located at the present Richmond Sanitary Service landfill.

---

* From ongoing Alameda County Planning Agency study information.

3D ALTERNATIVES UNACCEPTABLE AS LONG-TERM SOLUTIONS

3D.1 Richmond Landfill

This landfill has had periodic safety, nuisance, and environmental problems and may be subject to closure in the relatively near future. It is, therefore, not under further consideration as a long-term disposal alternative for Berkeley's refuse.

3E DISPOSAL COSTS

Estimated costs of transporting and disposing of unprocessed refuse at each of the disposal alternatives identified in Sections 3B and 3C are presented in Table 3-1.

3E.1 Transfer Station Costs

As conceptually designed in the Phase One Study, the transfer station is a totally enclosed building housing a receiving pit and a 40 ton per hour stationary compactor (Figure 3-2). Refuse received is dumped directly into the pit, broken up somewhat, and precompacted with a crawler type tractor. The tractor moves along the pit pushing refuse onto a horizontal metal pan conveyor. An inclined metal pan conveyor elevates and discharges the refuse into the compactor. The cost of owning and operating such a facility was estimated at $10.80 per ton.

3E.2 Transportation Costs

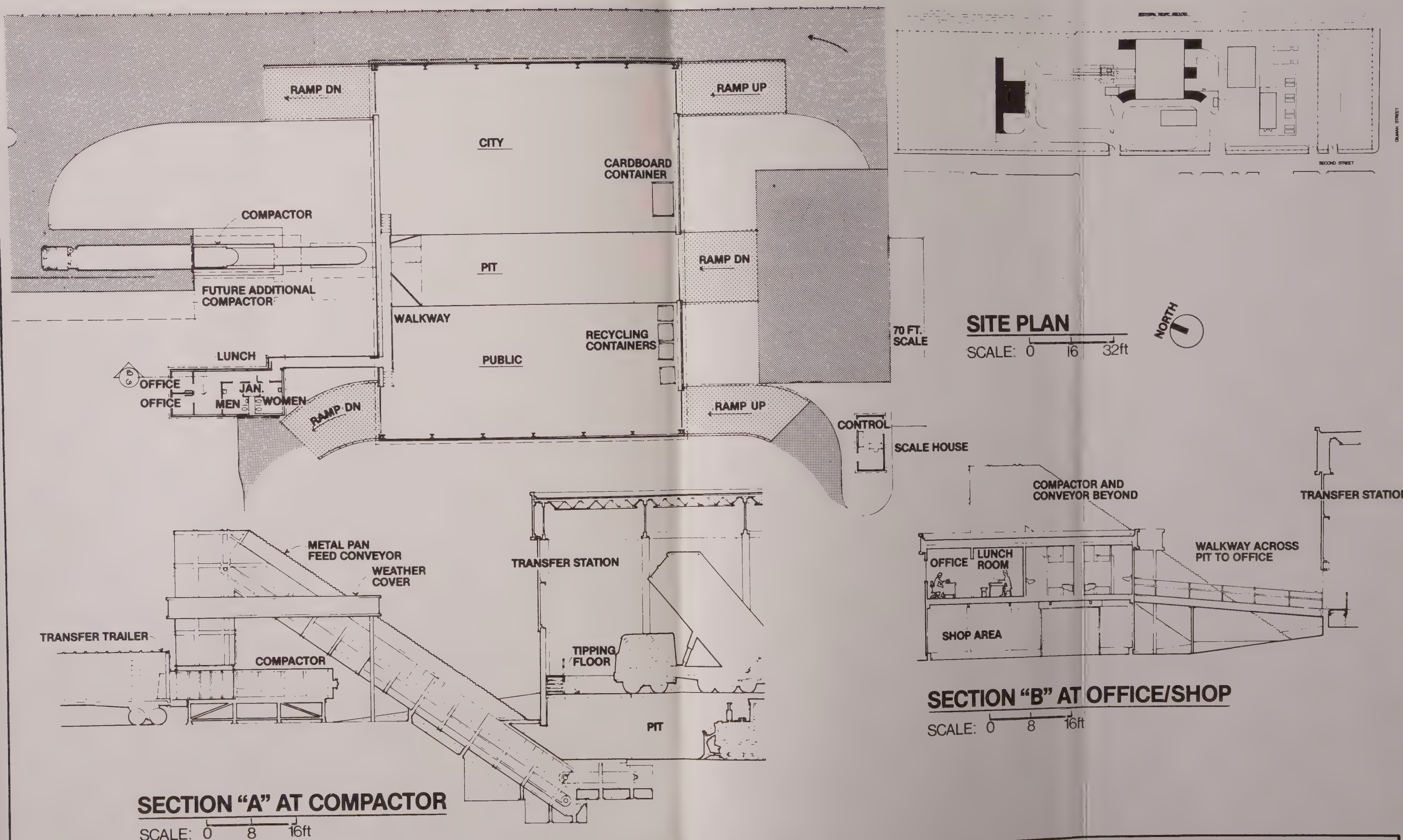
3E.2.1 Long Haul

Haul costs associated with the transfer station are based on the use of standard over-the-road vehicles with maximum legal payloads to 20 tons. The transfer vehicles are backed up and securely fastened to the compactor. The compaction ram forces refuse forward into the trailer through the rear in horizontal reciprocating cycles. Each trailer is equipped with a hydraulic-powered bulkhead which traverses the length of the trailer for unloading at the disposal site. Cost calculations, based on mileage and travel time are presented in Appendix E.

The total cost of transfer and haul is shown in Column 3 of Table 3-1.

3E.2.2 Direct Haul

As a comparison of the economies of transfer and haul, direct haul costs using 20 cubic yard collection vehicles were determined. Direct haul requires each collection vehicle to drive the round-trip distance to the disposal site. Assumptions and cost calculation are presented in Appendix E. As can be seen by comparing Columns 3 and 4 of Table 3-1, the economic advantages of transfer and haul are clearly demonstrated. The major cost disadvantage of direct haul over the distances and times considered for these disposal alternatives is the nonproductive



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TRANSFER STATION

FIGURE 3·2

TABLE 3-1

DISPOSAL ALTERNATIVES - TRANSPORTATION COST ANALYSIS

($ PER TON)

	(1) Transfer Station *a	(2) Long Haul *b	(3) Total Long Haul (1) + (2)	(4) Direct Haul *b	(5) Disposal Charge	(6) TOTAL COST Long Haul (3) + (5)	(7) TOTAL COST Direct Haul (4) + (5)
Existing Alternatives:							
•Acme Fill*c	10.80	4.65	15.45	21.70	5.00	20.45	26.70
•Vasco Road*c	10.80	5.95	16.75	37.40	3.85	20.60	41.25
Future Alternatives:							
•Altamont Pass*c	10.80	6.05	16.85	37.20	3.85	20.70	41.05
•City of Alameda*d	10.80	2.90	13.70	*e	6.00	19.70	--
•Davis Street*f	N/A*g	N/A	N/A	16.20	10.00 - 15.00	N/A	26.20 - 31.20
•Northern Alameda County*f	N/A	N/A	N/A	8.60	*h	N/A	*h
•U. S. Steel (Pittsburg)*d	10.80	5.70	16.50	32.10	*h	*h	*h
•West Contra Costa County (Richmond)*d	10.80	3.50	14.30	14.70	*h	*h	*h

*a Reference 1, haul cost subtacted from costs reported in Tables 5-3, 5-5, 5-6, and 6-1; costs escalated at ten (10) percent to 1978 price.
*b Cost calculations presented in Appendix E.
*c Landfill (Altamont Pass is proposed, whereas Acme Fill and Vasco Road are existing landfills).
*d Proposed Resource Recovery Facilities.
*e The City of Alameda has indicated an interest in receiving refuse by long haul vehicles only.
*f Proposed Transfer Station.
*g Not applicable due to double handling that would be involved.
*h Costs have not been established.

3E.2.2 (Continued)

labor time of a two-man crew, driving to and from the disposal site. The break-even points based on the assumptions presented in Appendix E are 34 round-trip minutes and/or 28 round-trip miles. This is the time and distance at which the costs of direct haul equal the cost of transfer and haul (refer to Appendix E for discussion). Beyond these points transfer and haul becomes cost-effective.

3E.3 Disposal Charge

By far the most uncertain of the cost involved in these disposal alternatives is the disposal charge. This stems mainly from the uncertainty of the alternatives themselves. The current drop charges at Acme Fill and Vasco Road are $5.00 and $3.85 per ton, respectively. Charges at Altamont Pass have not been established yet, but Oakland Scavenger estimates the charge will be approximately $3.85 per ton. Drop charges for the other alternative disposal sites have not as yet been established.

3E.4 Most Economical Alternative For Disposal of Unprocessed Refuse

Based on the presently available information, the most economical alternative for the disposal of unprocessed refuse is transfer and haul of unprocessed refuse to the proposed City of Alameda resource recovery facility at a total cost of $19.70 per ton. However, because this alternative is only speculative at this time, the least expensive currently existing alternative, $20.45 at Acme Fill landfill, will be used as the baseline cost to evaluate the feasibility of resource recovery systems in Berkeley.

3F ENERGY REQUIREMENTS FOR REFUSE DISPOSAL AT ACME FILL

In this section, the energy required for refuse disposal at the Acme Fill Landfill is presented. Energy consumption is examined for the three phases of the operation: transfer, haul, and disposal. Disposal at Acme Fill requires 64,400 tons per year to be transferred and hauled 52 round-trip miles, compacted and covered. Table 3-2 summarizes the estimated energy consumption.

Most of the energy would be consumed as diesel fuel by the equipment and vehicles. In order to better appreciate the amount of energy involved, the 12,180,000,000 British Thermal Units (BTU) projected per year is equivalent to 87,630 gallons of diesel fuel* consumed per year or about 1.4 gallons per ton of refuse transferred and buried. These figures do not include the energy consumed by the collection vehicles.

Details of how these estimates were made and comparisons with other studies are presented in Appendix F.

---

* Based on 139,000 BTU per gallon of diesel fuel.

TABLE 3-2

ENERGY REQUIREMENTS FOR TRANSFER AND HAUL TO ACME LANDFILL

Energy Consumption	Operation			
	Transfer	Haul	Landfill Disposal	System Total
BTU per ton *a transfered	55 000	87,500	42,000	179,500
BTU per year for 64,400 tons	3.58×10^9	5.36×10^9	2.73×10^9	11.67×10^9
Equivalent value in terms of gallons of diesel fuel				
• Per ton	0.4	0.6	0.3	1.3
• Per year *b	25,760	38,560	19,640	83,960

*a Refer to Appendix F.

*b Based on 139,000 BTU per gallon of diesel fuel, 64,400 tons per year.

3G ENVIRONMENTAL IMPACTS

The environmental impacts associated with the transfer and haul of unprocessed refuse to the Acme Fill Landfill in West Contra Costa County are identified in the following sections. This discussion is not an assessment or quantification of impacts but rather an identification of the impacts that should receive further consideration by the City's environmental consultants should the City choose to implement this alternative. A summary of the impacts associated with this alternative is presented in Table 3-3. For perspective, it should be noted that the Acme Fill Landfill currently receives an estimated 1,100 tons per day of waste (Reference 2). The delivery of Berkeley's refuse would result in an additional input of approximately 250 tons per day.

3G.1 Noise

3G1.1. Transfer

Significant sources of noise generation at the transfer station are: collection vehicles* (private, commercial, and City), the front-end loader* (operating on the floor), the crawler type tractor* (operating in the pit), the compactor, and tractors* pulling the transfer trailers. Observations made at operating transfer stations have indicated noise resulting from engine/transmission operation and the discharge of the refuse load by the vehicle packer mechanism are sounds heard the farthest from the building. In the proposed facility, the majority of operations, including vehicle maneuvering and unloading will be in an enclosed structure. This will not eliminate all sounds of vehicles entering and exiting the structure, but it is believed that noise levels from these sources will be compatible with the noise generated by the vehicle traffic on Gilman Street.

Noise levels inside the building will not exceed federal requirements for personal protection (i.e., 90 decibels for the duration of eight hours**). Existing transfer stations with equipment very similar to that proposed for Berkeley reportedly operate within Federal and State standards.

3G.1.2 Haul

Most of the route to the Acme Fill landfill is highway miles. The incremental noise levels added by the haul operation are considered insignificant. The final segment of the route to the landfill passes through a residential area along Arthur Road. Currently, collection vehicles delivering refuse to this landfill travel along Arthur Road. A significant increase in noise now generated in this area is not expected.

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* Produce an estimated 75 to 86 decibels at 45 feet according to discussions with manufacturers.

** Federal Register - Occupational Safety and Health Administration, Volume 37, Number 202, 1910.95.

TABLE 3-3

SUMMARY OF ENVIRONMENTAL IMPACTS
ASSOCIATED WITH TRANSFER AND HAUL

IMPACT	AT THE TRANSFER STATION	HAUL TO THE ACME FILL LANDFILL	AT THE ACME FILL LANDFILL
Noise	I	I	I
Air Quality	I	I	I
Dust	I	I	I
Odor	I	I	I
Traffic Congestion	S	I	I
Litter	S	I	I
Water Pollution	I	I	I

I Insignificant, if any.

S Could be significant.

3G.1.3 Disposal

The delivery and unloading of Berkeley's refuse by haul vehicles is not expected to increase current noise levels.

3G.2 Air Quality

3G.2.1 Transfer

It is assumed that the number of collection vehicles visiting the Gilman Street Site will be approximately the same as the number of vehicles now visiting the Berkeley landfill. This will result in a shift of emissions. Emissions from the diesel tractors pulling the transfer trailers, the crawler-type tractor and the front-end loader will also affect air quality at the site. The quantity of pollutants emitted by these engines can be determined using forthcoming Air Resources Board factors.* Although localized air quality at the site will be adversely impacted, the impact is not expected to be significant.

3G.2.2 Haul

The emissions from the diesel tractors pulling the haul trailers at an estimated 14 trips per day, average speed of 45 miles per hour can be estimated using forthcoming Air Resources Board emission factors for heavy duty vehicles using diesel fuel. The additional emissions resulting from haul of Berkeley refuse to the Acme Fill Landfill should then be considered in terms of current average levels of pollutants generated in the West Alameda and West Contra Costa County areas. The generation of any additional air pollutants is an adverse impact and should be minimized. However, the emissions generated are not expected to have a significant impact on air quality.

3G.2.3 Disposal

It is expected that the delivery and unloading of Berkeley's refuse at the rate of 14 trips per day and the landfilling of this additional refuse will significantly increase emissions now generated at the Acme Fill Landfill.

3G.3 Dust

3G.3.1 Transfer

Dust will be generated by the unloading of collection vehicles and the loading of the haul vehicles. Because unloading will

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* The California Air Resources Board is in the process of revising emission factors for use in determining emissions. These factors will soon be available, pending U. S. Environmental Protection Agency approval.

TABLE 3-3

SUMMARY OF ENVIRONMENTAL IMPACTS
ASSOCIATED WITH TRANSFER AND HAUL

IMPACT	AT THE TRANSFER STATION	HAUL TO THE ACME FILL LANDFILL	AT THE ACME FILL LANDFILL
Noise	I	I	I
Air Quality	I	I	I
Dust	I	I	I
Odor	I	I	I
Traffic Congestion	S	I	I
Litter	S	I	I
Water Pollution	I	I	I

I Insignificant, if any.

S Could be significant.

3G.1.3 Disposal

The delivery and unloading of Berkeley's refuse by haul vehicles is not expected to increase current noise levels.

3G.2 Air Quality

3G.2.1 Transfer

It is assumed that the number of collection vehicles visiting the Gilman Street Site will be approximately the same as the number of vehicles now visiting the Berkeley landfill. This will result in a shift of emissions. Emissions from the diesel tractors pulling the transfer trailers, the crawler-type tractor and the front-end loader will also affect air quality at the site. The quantity of pollutants emitted by these engines can be determined using forthcoming Air Resources Board factors.* Although localized air quality at the site will be adversely impacted, the impact is not expected to be significant.

3G.2.2 Haul

The emissions from the diesel tractors pulling the haul trailers at an estimated 14 trips per day, average speed of 45 miles per hour can be estimated using forthcoming Air Resources Board emission factors for heavy duty vehicles using diesel fuel. The additional emissions resulting from haul of Berkeley refuse to the Acme Fill Landfill should then be considered in terms of current average levels of pollutants generated in the West Alameda and West Contra Costa County areas. The generation of any additional air pollutants is an adverse impact and should be minimized. However, the emissions generated are not expected to have a significant impact on air quality.

3G.2.3 Disposal

It is expected that the delivery and unloading of Berkeley's refuse at the rate of 14 trips per day and the landfilling of this additional refuse will significantly increase emissions now generated at the Acme Fill Landfill.

3G.3 Dust

3G.3.1 Transfer

Dust will be generated by the unloading of collection vehicles and the loading of the haul vehicles. Because unloading will

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* The California Air Resources Board is in the process of revising emission factors for use in determining emissions. These factors will soon be available, pending U. S. Environmental Protection Agency approval.

3G.3.1 (Continued)

occur inside the Transfer Station building and conveyance of refuse outside for compaction will occur inside covered conveyors, dust generation is expected to impact the local community only slightly, if at all. Building design and construction will conform to Federal and State codes for personal protection from dust. Because the haul vehicles and the compactor are coupled during loading, dust generation from this activity should not be a significant impact.

3G.3.2 Haul

The quantities of dust generated by the haul operation are considered to be insignificant.

3G.3.3 Disposal

Dust generated by the unloading, disposal, and covering of refuse at a landfill is a problem common to landfilling. Operating procedures at the Transfer Station where the waste is loaded as well as at the landfill can often minimize the quantity of dust generated. Disposal of Berkeley's wastes at Acme Fill Landfill is not expected to significantly increase dust generated at the landfill.

3G.4 Odor

3G.4.1 Transfer

When mixed refuse has been allowed to accumulate in an environment conducive to putrefaction, objectionable odors occur. To minimize these conditions, the receiving area is designed and staffed to handle peak day loads with adequate time provided for a thorough daily cleanup. If complaints are registered with the Bay Area Air Pollution Control District (BAAPCD) and it is determined that odors exceed specified limitations (Division 15 of BAAPCD Regulation 2), mitigation measures could be required.

3G.4.2 Haul

The refuse will be completely contained in sealed trailers. Therefore, no odors should emanate during the haul operation.

3G.4.3 Disposal

The generation of odors at the landfill is not expected to increase noticeably as a result of accepting Berkeley's wastes.

3G.5 Traffic Congestion

3G.5.1 Transfer

The average number of vehicles that will be visiting the Transfer Station is estimated in Table 3-4 to be 339 on weekdays and 457 on Saturday. (This includes collection, transfer,

TABLE 3-4

ESTIMATED VEHICLE COUNT AT TRANSFER STATION [*a]

	WEEKDAYS	WEEKENDS
Collection Vehicles[*b] (Private, Commercial, and City)	305	433
Transfer Vehicles	14	4
Transfer Station Employee Cars[*b]	20	20
	339	457

*a Does not include traffic generated by other SWMC activities (i.e., Corporation Yard, Storage Depot, and Recycling Center).

*b Reference 1.

3G.5.1 (Continued)

employee, public, and private vehicles.) This may significantly increase traffic congestion on Second and Gilman Streets and on neighboring streets.

3G.5.2 Haul

3G.5.2.1 Highways 80 and 4

Highways 80 and 4 are already congested during peak periods. In addition to increasing this congestion, which is not expected to be significant, transfer trucks would be slowed considerably during these periods. Careful scheduling of transfer trucks to avoid afternoon congestion should be considered.

3G.5.2.2 Pacheco Boulevard and Arthur Road

These streets form the last segment of the trip to Acme Fill Landfill. Collection and transfer vehicles currently travel these streets to and from the landfill. The impacts of increasing the truck traffic on these roads by the estimated fourteen (14) vehicle trips per day is not expected to be significant.

3G.5.3 Disposal

No significant traffic congestion is expected by the additional fourteen (14) trips per day.

3G.6 Litter

3G.6.1 Transfer

Increases in litter generation at the site could be significant. The site will be fenced to contain the litter and litter cleanup will have to occur on a regular basis. Transfer Station staff should instruct anyone visiting the site to properly cover and unload refuse brought to the site so as to minimize littering.

3G.6.2 Haul

Because the refuse in haul trailers is compacted and completely contained inside the truck, these vehicles are not expected to increase litter along the route to the landfill.

3G.6.3 Disposal

The unloading of Berkeley's refuse at Acme Fill is not expected to increase litter at the landfill.

3G.7 Water

3G.7.1 Transfer

Washdown water for area and/or transport vehicles is usually quite contaminated and requires sewage treatment. For purposes of preliminary design, this water is discharged to the sewer system. Final design will investigate the feasibility of recycling this water and the possible requirement for pretreatment before discharge to the sewer system.

3G.7.2 Haul

As the refuse is completely contained in sealed trailers, no water pollution should occur during haul operation.

3G.7.2 Disposal

The Acme Fill Landfill is operated in compliance with State-imposed discharge requirements in a manner which minimizes impact on the ground and surface waters. If present standards of operation are maintained, no significant water pollution impacts should result from the additional refuse delivered by Berkeley.

CHAPTER 4

RESOURCE RECOVERY ALTERNATIVES

4A INTRODUCTION

Appropriate resource recovery systems which produce marketable products and offer the flexibility of modular development were identified on the basis of preliminary marketing discussion with local industry (Reference 1), trade literature, vendor contact, and comments from the City of Berkeley and the State Solid Waste Management Board. Systems not considered appropriate for Berkeley were eliminated from further consideration because of high cost, inadequate technological development, inappropriate scale, and/or inadequate market potential. These systems appear in Section 4F.

Candidate systems are described in Sections 4B through 4E. They include the following:

1. Pyrolysis Systems

2. Waterwall Combustion Systems

3. Package Incinerators With Heat Recovery

4. Refuse Derived Fuel (RDF) Production System.

These systems are evaluated with respect to their technical reliability, environmental acceptability, energy productivity, and economic acceptability in Sections 4G, 4H, 4I, and Chapter 5. Specific information on existing facilities for each category is provided in Table 4-1.

4B PYROLYSIS

4B.1 General Discussion

Pyrolysis is a broad term given to a variety of processes that decompose processed waste or unprocessed waste by the action of heat in an oxygen-deficient atmosphere. The fuels produced by these pyrolytic processes can be either combustible gases or liquids, depending on operating conditions. These products may either be burned immediately to produce steam or, in some cases, they can be transported and sold to other users (Reference 4).

Most pyrolysis systems are currently in the development stage. Two systems were, however, considered appropriate to handle Berkeley's municipal solid waste. Both produce a low energy gas that is converted on-site to steam or electricity. They are:

- Andco-Torrax Process

- BSP Pyrolyser Process

TABLE 4-1

LOCATION OF RESOURCE RECOVERY FACILITIES

System	Process	Manufacturer	Installation Location	Operating Capacity (Tons Per Day)	Product	Status	Visited?
Pyrolysis	Andco-Torrax	Torrax Div., Carborundum Environmental Sciences	Frankfurt, West Germany	200*a	Steam	Construction	No
			Grasse, France	120*a	Steam	Construction	No
			Luxembourg	200*a	Steam	Operational	No
	BSP Pyrolyser	Envirotech Corp.	Concord, CA	144*b	Steam	Demonstration (No longer in use)	N/A
			Concord, CA	600*b	Steam	Design	N/A
Waterwall Combustion	Unprocessed Solid Wastes	Foster-Wheeler, Detroit Stoker	Norfolk, Virginia	200	Steam	Operational	Yes
		E. Keeler, Detroit Stoker	Portsmouth, VA	160	Steam	Operational	No
		Universal Oil Products, Martin	Chicago, Illinois (Northwest)	1,600	Steam	Operational	Yes
		Riley Stoker	Braintree, Mass.	240	Steam	Operational	No
		Universal Oil Products, Martin	Harrisburg, Penn.	720	Steam	Operational	No
		Babcock & Wilcox, Detroit Stoker	Nashville, Tenn.	600	Steam	Operational	Yes
		Wheelabrator-Frye, Von Roll	Saugus, Mass.	750	Steam	Operational	Yes
	Shredded Solid Wastes	Babcock & Wilcox, Detroit Stoker	East Hamilton, Ontario	300	Steam	Operational	No
	RDF/Supplemental Fuel	Combustion Engineering Riley Stoker	Ames, Iowa	150*c	Electricity	Operational	Yes
		Combustion Engineering	Chicago, Illinois (Southwest)	1,000*c	Electricity	Start-up	Yes
		Not Specified	Humboldt County, California	825*d	Electricity	Pre-design	N/A
		Combustion Engineering	St. Louis, Missouri	300*c	Electricity	Demonstration (No longer in use)	N/A

TABLE 4-1 LOCATION OF RESOURCE RECOVERY FACILITIES

System	Process	Manufacturer	Installation Location	Operating Capacity (Tons Per Day)	Product	Status	Visited?
Waterwall Combustion (Cont'd)	RDF/100%	Foster-Wheeler	Niagara Falls, N.Y. (Hoover Chemical)	2,200	Steam/Elec.	Construction	N/A
		Babcock & Wilcox Detroit Stoker	Akron, Ohio	1,000	Steam	Construction	N/A
		Consumat System, Inc.	Bellingham, Wash.	100	None	Operational	Yes
			Blytheville, Ark.	50	Steam	Operational	No
			Coquille, Oregon	10	None	Operational	No
			North Little Rock, Ark.	100	Steam	Operational	Yes
			Siloam Springs, Ark.	19	Steam	Operational	No
Package Incinerators		Kelley Co.	Auburn, N.H.		None		
			Bridgewater, N.H.	--	None	Operational	No
			Candia, N.H.	--	None	Operational	No
			Canterbury, N.H.	--	None	Operational	No
			Meredith, N.H.	20TPD	None	Operational	Yes
			Nottingham, N.H.	10	None	Operational	No
			Pittsfield, N.H.	15TPD	None	Operational	Yes
			Wolfeboro, N.H.	20TPD	None	Operational	Yes
RDF Production		Americology Division, American Can	Milwaukee, Wisc.	600	RDF[f]	Start-up	Yes
		Combustion Equipment Associates, Inc.	East Bridgewater, Mass.	50	Eco-Fuel II[f] (dust RDF)	Operational	No
		Ratheon Service Co.	Monroe County, N.Y.	2,000	RDF[f]	Start-up	No
		Teledyne National	Baltimore Co., Md.	600	RDF[g]	Start-up	Yes
		Waste Management, Inc.	New Orleans, La.	650	RDF[g]	Start-up	Yes

*a Unprocessed solid wastes.
*b Co-disposal of RDF and sewage sludge. Tonnages indicated are RDF tons only.
*c RDF used as a supplemental fuel to coal. Tonnages indicated are RDF tons only.
*d RDF used as a supplemental fuel to wood wastes. Tonnages indicated are the combined total.
*e Package incinerators handle unprocessed solid wastes.
*f Used as a supplemental fuel to coal.
*g Markets have not been established.

4B.2 Andco-Torrax Process

The Andco-Torrax Process is manufactured and marketed by the Andco Corporation. Licensing agreements are also held by Carborundum Corporation.

The principal components of the Andco-Torrax Process (Figure 4-1) are the gasifier, secondary combustion chamber, primary air pre-heating regenerative towers, boiler system, and the gas cleaning system (Reference 5). Unprocessed solid waste is charged into the gasifier. The gasifier is a vertical shaft furnace designed so that the descending refuse and the ascending high temperate gases become a counter-current heat exchanger.

The heat for pyrolyzing and drying the solid waste and for melting the inert fraction is produced by the combustion of the carbon char (produced from the process) with the aid of 1,800° F. preheated air supplied to the hearth zone of the gasifier from the regenerative towers. Combustion temperatures reach 3,000° F. The heat thus generated melts the inerts to form a molten slag, which is drained continuously through a sealed tap into a water quench tank to produce a black, granulated residue.

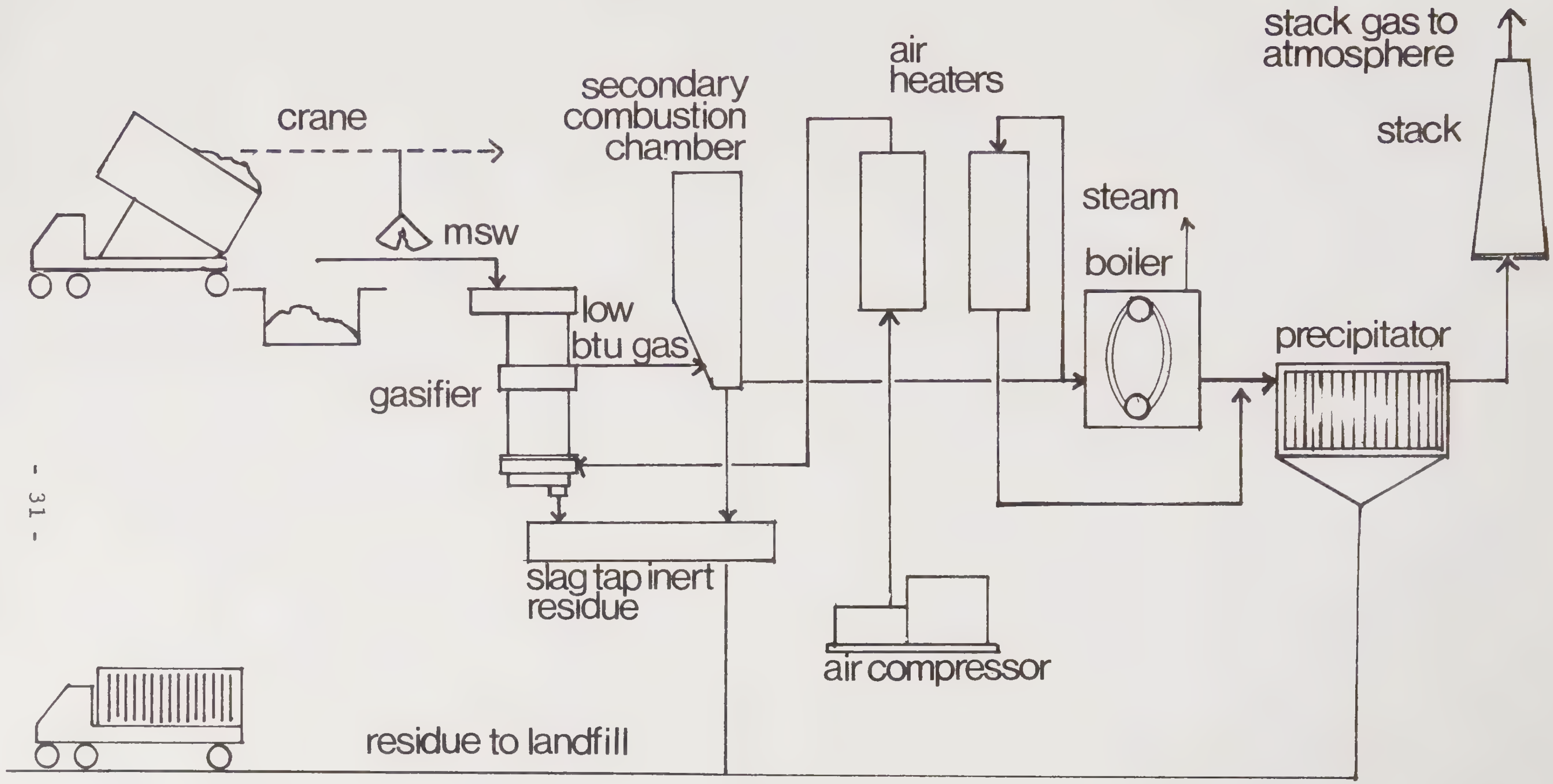
The energy value of the gas produced is too low to make off-site transportation of the gas economical. Instead, the gases are injected into an after-burner or secondary combustion chamber where they are burned to completion. The heat which is thus released is then directed to a waste heat boiler where it is recovered as steam.

The cooled waste gases from the boiler are ducted to an electrostatic precipitator of conventional design for air pollution control.

To gain operating experience, Andco-Torrax operated a 75 tons-per-day (TPD) demonstration facility in Erie County, New York. From the experience gained in Erie County, Andco built its first full-scale facility (200 TPD) in Luxembourg in 1976. This facility has been operating successfully since the fall of 1977 producing steam for electrical production. Andco presently has another operating facility (120 TPD) producing process steam in Grasse, France which has been operating continuously since early 1978. A third facility located in Frankfurt, West Germany, is currently undergoing startup and will process 200 TPD for steam production. A fourth facility (400 TPD) under construction in Creteil, France is expected to be completed in early 1979.

4B.3 BSP Pyrolyser Process

The BSP Pyrolyser Process is marketed by the Envirotech Corporation of Belmont, California. During the summer of 1976, the process was demonstrated at three (3) tons per hour in Concord, California at an existing wastewater treatment facility in combination with sewage sludge disposal (Reference 4).



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ANDCO-TORRAX
PYROLYSIS PROCESS

FIGURE 4·1

The process (Figure 4-2) consists of pneumatically conveying processed refuse (RDF) into a multiple hearth furnace (pyrolyser). Refuse is moved progressively from upper level to lower level hearths by rotating rabble arms. A small percentage of the combustibles are burned in the process to evaporate refuse moisture and furnish heat for decomposition at approximately 2,000° F. The waste gas is passed through an afterburner and a waste heat boiler (and a turbine generator if electricity is produced), then through a wet scrubber for purposes of air pollution control prior to being vented to the atmosphere. Char accumulated at the bottom of the furnace is collected in a quench tank and disposed (Reference 6).

A 600 TPD co-disposal (RDF and sludge) facility is approaching final design in Contra Costa County, California. There are no existing units operating solely on RDF.

4C WATERWALL COMBUSTION SYSTEMS

Commonly called "waterwall incinerators," these systems involve burning solid waste in a specially designed furnace jacketed with water-filled tubes to recover heat. Heat is recovered as steam which can be used directly or can be converted to electricity.

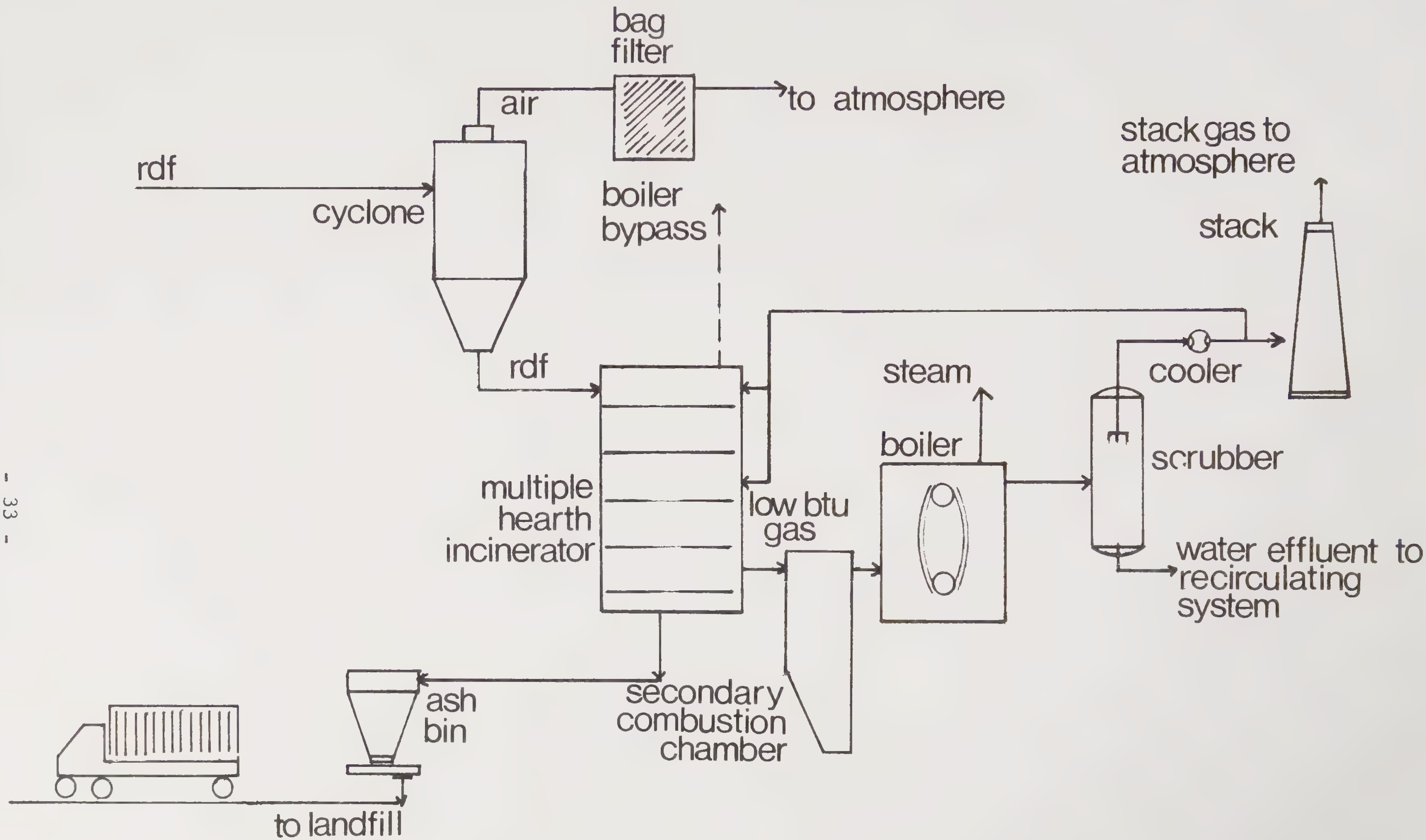
Waterwall Combustion Systems or components are available from a variety of manufacturers. Wheelabrator-Frye (representing the Von Roll Company of Zurich) and Universal Oil Products (representing the Josef Martin Company of Munich) are marketing complete systems. Components (boilers and stokers) are available from Babcox and Wilcox, Combustion Engineering, E. Keeler, Foster-Wheeler, Zurn Energy Systems, Riley Stoker, and Detroit Stoker.

Three types of Waterwall Combustion Systems are marketed today. These systems are characterized by the form of solid waste utilized: unprocessed, shredded, or RDF (Reference 4).

4C.1 Unprocessed Wastes

In this type of system (Figure 4-3) solid waste is burned, without prior processing, on mechanical grates (stokers) which move it through the furnace. Noncombustible material falls off the end of the grate where it is quenched with water and then conveyed to trucks or a temporary storage pit. Ferrous metal may be recovered from the ash residue.

Application of waterwall incinerator technology in the United States for the recovery of waste heat has been recently encouraged by the success of European experience. The first large-scale United States



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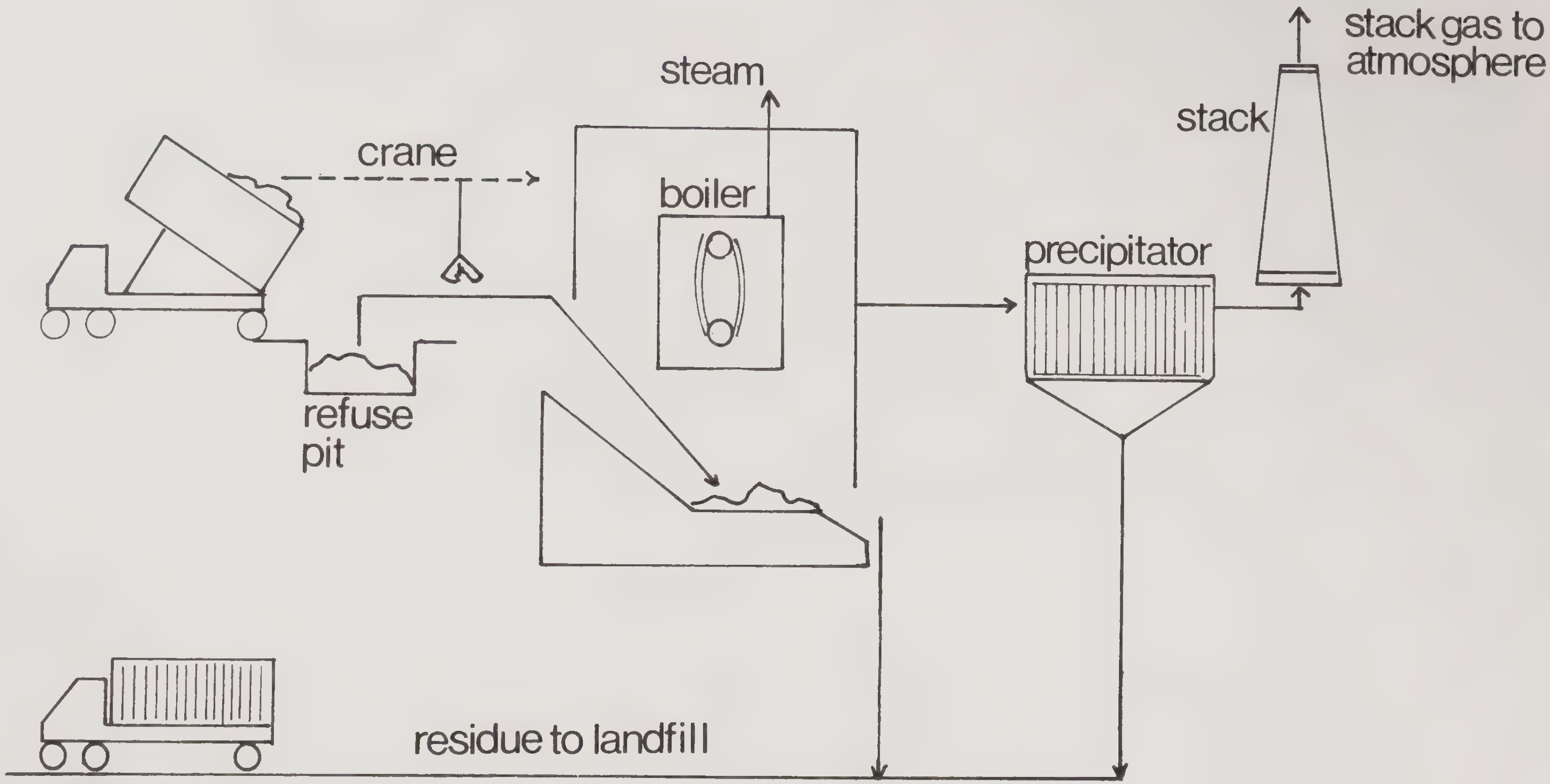
BSP PYROLYSER
PROCESS

FIGURE 4·2



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WATERWALL COMBUSTION
UNPROCESSED MSW

FIGURE 4·3

4C.1 (Continued)

solid waste burning furnace utilizing waterwall technology to recover steam is at the U. S. Naval Station in Norfolk, Virginia. This 200 TPD plant has operated since 1967. The steam produced is used to satisfy the Station's requirements for heating and cooling. Another facility was recently completed in Portsmouth, Virginia which also supplies steam to the Norfolk Naval Station. This facility processes 160 TPD of solid waste. Other facilities have been operated for several years, but for nontechnical reasons, steam has been sold only intermittently. These facilities are located in Chicago, Illinois; Braintree, Massachusetts; and Harrisburg, Pensylvania.

In Nashville, Tennessee, a facility has been in operation since 1974 burning 600 TPD. Steam from this plant is distributed through a utility loop to several dozen large government and private buildings. Steam is also used to operate two chillers so that cooled water can be distributed. Both heating and cooling are provided 24 hours per day, 365 days per year.

Another steam generating incinerator, which is located in Saugus, Massachusetts, sells superheated steam to an adjacent industrial user. This plant, which began operating in 1976, was privately constructed as a profit-making venture. It is owned jointly by a combustion systems manufacturer and a waste disposal contractor.

4C.2 Shredded Wastes

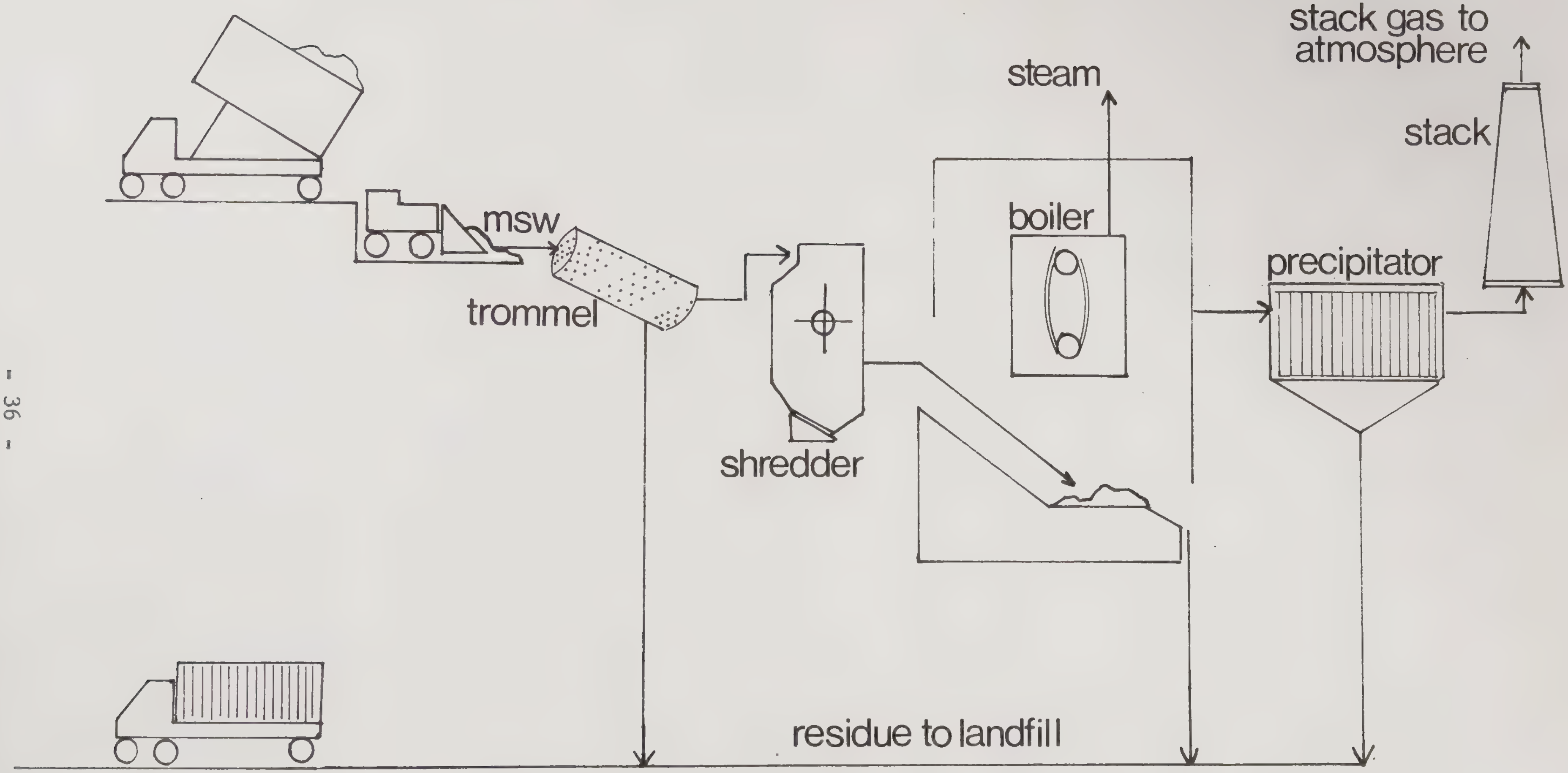
The purpose of shredding solid waste prior to combustion is to produce a more homogeneous and thus more controllable fuel. In this type of system, as-received solid waste is coarsely shredded prior to being mechanically or pneumatically charged into the furnace and burned on a moving grate. This type of firing is often referred to as semi-suspension firing because the waste is ignited while it is falling through the chamber, but combustion is completed while it rests on the grate. A typical waterwall combustion system for shredded wastes is illustrated in Figure 4-5.

One such plant is currently in use in Hamilton, Ontario processing 300 TPD of municipal solid waste, and several others are in use burning industrial wastes. A similar municipal solid waste plant is being constructed in Albany, New York. This facility will process 750 TPD.

4C.3 Refuse Derived Fuel (RDF)

Further processing solid wastes into a light combustible fraction (called refuse derived fuel or RDF; refer to Section 4E for discussion) permits its use as a supplemental fuel in waterwall boilers designed to burn coal, wood, or heavy oil. The greater degree of processing reduces the ash content of refuse fuels and results in an even more homogeneous fuel than that produced by coarse shredding.

A typical Waterwall Combustion System for RDF is illustrated in Figure 4-5.



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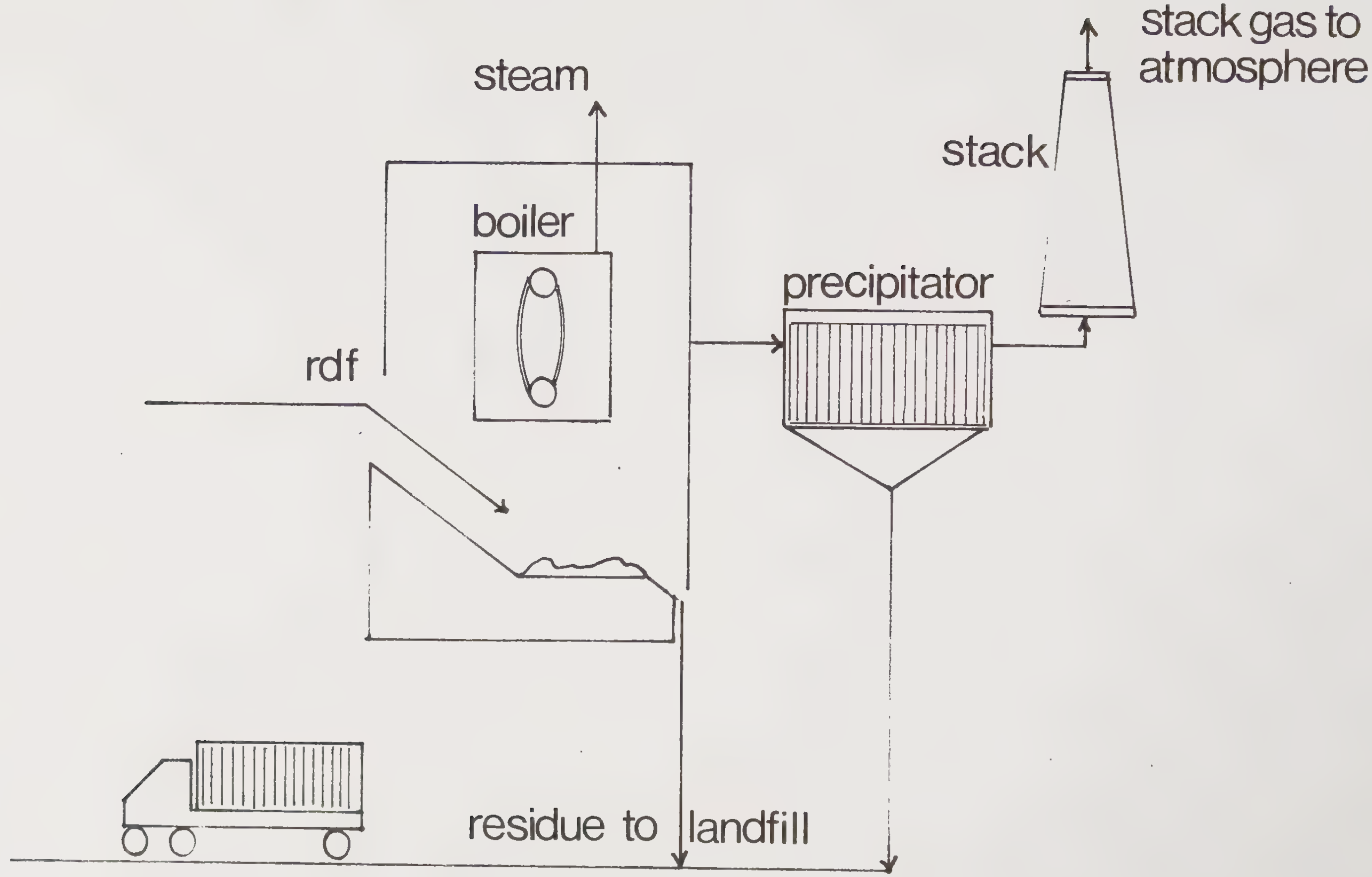
WATERWALL COMBUSTION
SHREDDED MSW

FIGURE 4·4



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WATERWALL COMBUSTION
RDF

FIGURE 4·5

The major utilization of RDF to date has been as a supplemental fuel in large, suspension, and semi-suspension-fired power plant boilers which normally burn pulverized coal to generate electricity. RDF is most commonly used with coal because (1) existing boilers are already fitted with equipment for handling bottom ash and fly ash, and (2) the boilers can be modified at relatively low cost to accept RDF. Rates of utilization of RDF vary from 5 to 20 percent of the total heat input (Reference 2). In four cities: Ames, Iowa; Milwaukee, Wisconsin; Chicago, Illinois' and St. Louis, Missouri electric power plants are burning (or plan to burn) the combustible portion of the City's refuse as supplemental fuel to coal.

The use of RDF as a supplemental fuel in a wood waste boiler has been studied (Reference 8 and Reference 9). The State Solid Waste Management Board is in process of funding further development of such a concept in Humboldt County, California.

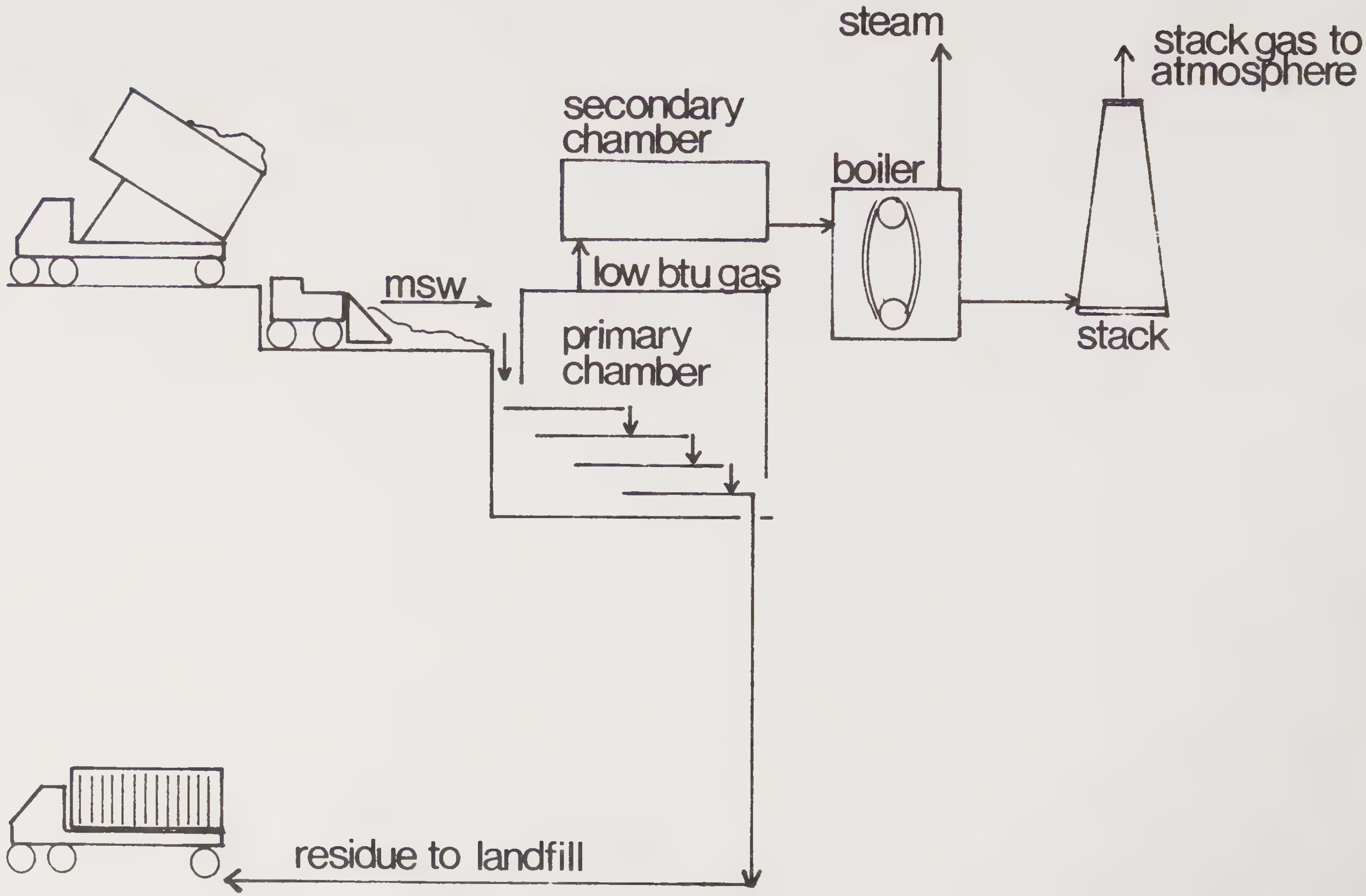
There are currently two facilities under construction designed to burn 100 percent RDF. One of these facilities will be located in Niagara Falls, New York, and will process 2,200 TPD of municipal solid wastes. The RDF will be used to generate electricity for use at the Hooker Chemicals and Plastics Corporation facility. The other facility will be located in Akron, Ohio, and will process 1,000 TPD. Steam will be used for urban heating and cooling and industrial use.

4D PACKAGE INCINERATORS

The attractiveness of the Package Incinerator stems from its modularity, (i.e., its ability to be coupled with other such units to process the available tonnage) and the absence of air pollution equipment requirements. Each individual unit can handle one to four tons per hour. These modular incinerators are particularly applicable to small communities and communities desiring a phased development in resource recovery.

Package Incinerators incorporating a controlled air principle (Figure 4-6) utilize unprocessed solid waste along with a small amount of fuel for start-up. Solid waste is fed into a primary chamber, where it is burned slowly under controlled air conditions. The resulting gas is passed through a second chamber, where excess air is injected. Auxiliary fuel is required in minimal quantities to maintain proper combustion temperatures. The particulate matter burns off, and the hot effluent is passed through a waste heat boiler to produce steam. Ash is water-quenched and landfilled for disposal. The steam can then be used to generate electricity with the addition of a turbine generator if desired. The incinerators are factory built, highway shippable, and can be assembled into clusters. (Reference 10). Ferrous metal may be recovered from the ash residue or from preprocessing procedures.

While Package Incineration is a well-established practice, energy recovery from these units is a relatively new technology. Cities currently processing their municipal refuse and recovering steam are as follows:



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CITY OF BERKELEY

TYPICAL PACKAGE INCINERATOR

FIGURE 4·6

4D (Continued)

- Blytheville, Arkansas (13 TPD)
- Siloam Springs, Arkansas (19 TPD)
- North Little Rock, Arkansas (100 TPD)

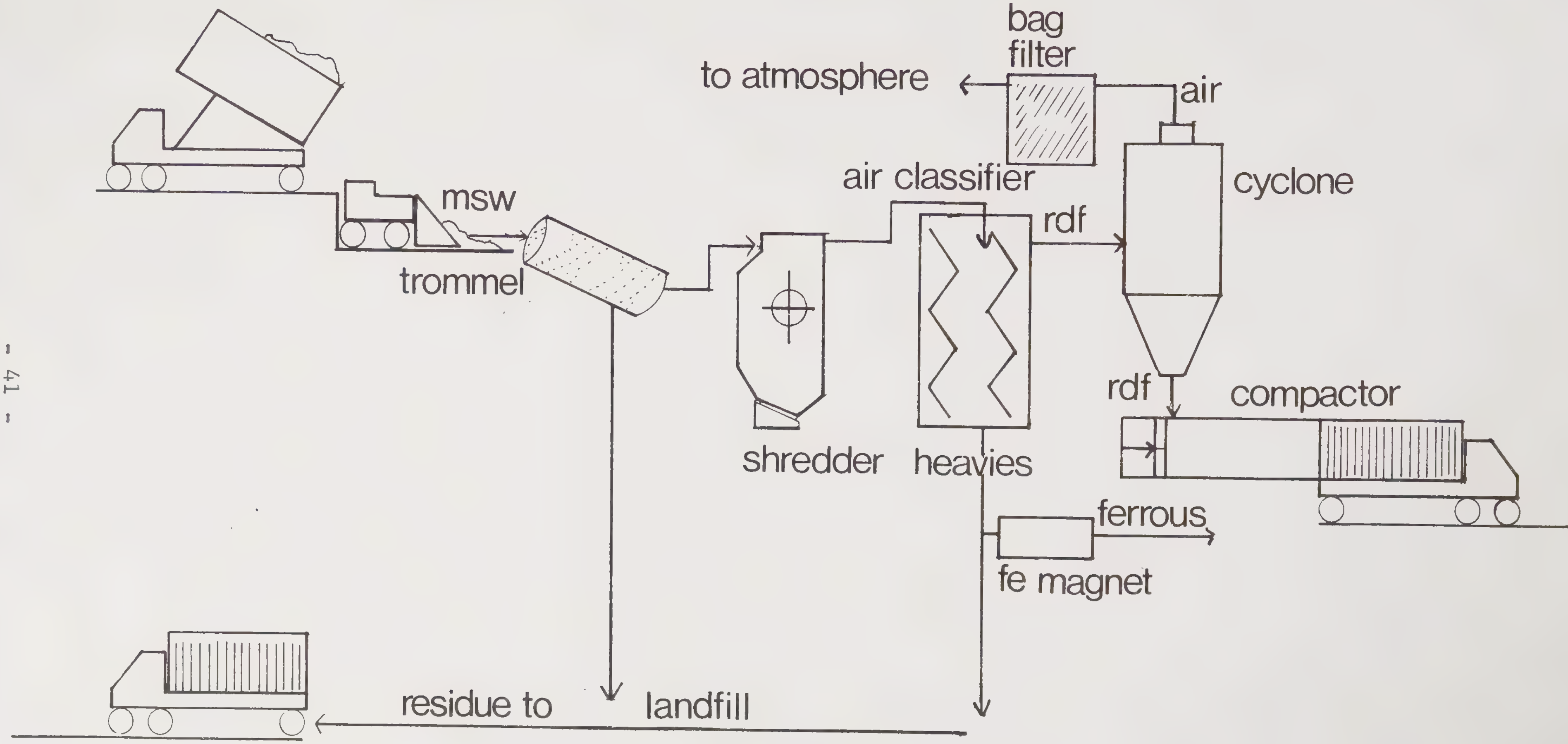
There are a number of cities utilizing these units without energy recovery. They include: Auburn, Nottingham, Bridgewater, Candia, Meredith, Canterbury, Pittsfield, and Wolfeboro, New Hampshire; Coquille, Oregon; and Bellingham, Washington. It should be noted that the owners of the Bellingham facility intend to produce steam when a user is developed.

Representative manufacturers include Basic Environmental Engineering, Inc., the Comptro Division of Sunbeam Equipment Corporation, Consumat Systems, Inc., Environmental Control Products, Inc., and Kelley Company.

4E RDF PRODUCTION SYSTEMS

The term "refuse-derived fuel" refers to the combustible portion of solid waste that has been separated from the noncombustible portion through various processes, e.g., shredding and air classifying. With processing, RDF containing 10 to 13 million BTU's per ton can be produced at the rate of 55 to 85 percent of refuse input. A typical RDF plant is illustrated in Figure 4-7. Since RDF Production was first demonstrated at St. Louis, a great deal has been learned about controlling particle size so as to achieve complete combustion in the boiler and reducing ash content by removing inorganic (noncombustible) fines with mechanical processing. Based on reports of the experience at St. Louis and at other facilities producing RDF, an RDF Production System for the SWMC was conceptualized in the Phase One Study. The proposed system includes the following steps:

- Solid waste is fed into a trommel (rotating screen) to remove glass and dirt.
- The remaining fraction is conveyed to a shredder for size reduction.
- Shredded wastes are passed through an air classifier to separate the "light fraction" (plastics, paper, wood, textiles, food wastes and small amounts of light metals) from the "heavy fraction" (metals, aluminum, small amounts of glass, and ceramics).
- The light fraction, after being routed through a magnetic system to remove ferrous metals, is ready for use as fuel.
- The heavy fraction is conveyed to a magnetic removal system for ferrous metal recovery.
- The remaining heavy fraction goes to landfill.



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CITY OF BERKELEY

TYPICAL RDF
PRODUCTION SYSTEM

FIGURE 4·7

4E (Continued)

RDF Production Systems may be designed and put together on a component basis with the necessary units of equipment (i.e., trommel, shredder, air classifier) procured from the various manufacturers and then assembled into a system. Also available are predesigned RDF Production Systems marketed by various manufacturers. Such systems are purchased as a unit.

Five representative manufacturers marketing complete RDF Systems include: (1) The Americology Division of Amercian Can (developed the 600 TPD RDF Production System at Milwaukee, Wisconsin, now undergoing start up); (2) Combustion Equipment Associates (CEA)(developed the dust RDF (Eco-Fuel II) production process, a proprietary process, at the Bridgewater, Massachusetts facility which is currently processing 50 TPD. CEA is also developing the system for the Berlin, Connecticut facility, now in the design stage, where Eco-Fuel II will be produced from 800 to 1,400 TPD of refuse); (3) Raytheon Service Company (the developers of the system at the Monroe County, New York plant (2,000 TPD) now undergoing start up); (4) Teledyne National (developed the Baltimore County, Maryland facility, also undergoing start up which has the capacity to process between 400 and 1,200 TPD of refuse); and finally, (5) Waste Management, Inc. (the developer of the facility in New Orleans, Louisiana, now undergoing start up and with a design capacity of 650 TPD).

4F SYSTEMS NOT CONSIDERED APPROPRIATE FOR BERKELEY

The following is a list of resource recovery alternatives that, for reasons of high cost, inadequate technological development, inappropriate scale, and inadequate market potential, are deemed inappropriate for consideration in Berkeley:

- Ammonia Production Systems
- Augered Bed Incinerator Systems
- Basket Grate Incinerator Systems
- Biogassification Systems
- Black-Clawson Wet Pulping Process
- Composting Systems
- Coors Pyrolysis Process
- Deco Pyrolysis Process
- Enzyme to Protein System
- Ethanol Production Systems
- Fluidized Bed Combustion Systems (CPU 400 Process)

4F (Continued)

- Hydrogen Production Systems
- Methanol Production Systems
- Monsanto-Langard Pyrolysis Process
- Occidental Pyrolysis Process
- Purox Pyrolysis Process
- Resource Sciences Pyrolysis Process
- Wallace Atkins Pyrolysis Process
- Worm Farming Systems.

Justification for the elimination of these systems, provided by the State Solid Waste Management Board, is presented in Appendix G.

4G TECHNICAL ASPECTS OF IDENTIFIED SYSTEMS

4G.1 Introduction

Energy recovery from solid waste is a relatively new concept precipitated by the shortage of sanitary landfills in highly populated areas, by adverse public reaction to the location and presence of landfills and concern about the availability and spiraling costs of energy.

This section presents a discussion of the more important technical aspects to be considered by decision makers when choosing a solid waste energy recovery system.

4G.2 Technical Aspects

Technical aspects that deserve consideration by a municipality evaluating a resource recovery system are as follows:

- Technology demonstration
- Reliability
- Flexibility
- Ease of operation
- Ease of maintenance.

The following subsections discuss these aspects.

4G.2.1 Technology Demonstration

Energy recovery from solid wastes is a relatively new and rapidly developing technology in the United States. Research and development required to bring a specific technology to the point where it can be relied upon takes a number of years. Each new installation is refined based on the successes and failures of preceding projects. Also, similar installations provide a basis for predicting the performance of a system within the site specific situation of a municipality.

4G.2.2 Reliability

Any system selected must be designed, constructed, and operated in a manner to minimize down time. Excessive down time may result in having to direct haul to a local landfill and the failure to meet energy product delivery requirements. Built-in redundancy would avoid complete system shutdown.

4G.2.3 Flexibility

The need for flexibility and ease of alteration is due to a number of variable factors including:

- Future capacity requirements;
- Change in laws concerning the environment;
- Change in composition of Municipal Solid Waste (MSW);
- Uncertanties regarding the relative values of energy products and recycled materials;
- Future technical developments.

Flexibility is desirable in a waste to energy system in order to more easily adapt to any of the above variables during the life of the project. System modularity offers the greatest degree of flexibility. For the waste stream quantity in Berkeley, fifty (50) TPD modules are considered ideal.

4G.2.4 Ease of Operation

Ease of operation relates to the systems operating complexity. Highly complex operations would make proper performance contingent upon the availability of highly skilled personnel. It is an indicator of the difficulty of day to day operation.

4G.2.5 Ease of Maintenance

Ease of maintaining a system and availability of parts and service are extremely important. In addition to normal wear and tear, processing solid waste results in corrosion and abrasion. This leads to breakdowns. Highly vulnerable systems with frequent and/or expensive breakdowns should be avoided.

4G.3 Evaluation of Systems Under Consideration

Each of the systems identified in Sections 4B through 4E, as being appropriate for initial consideration for Berkeley's SWMC is evaluated below in light of the technical aspects discussed above. Evaluations are based on plant visits, discussions with knowledgeable individuals, companies and agencies, and literature reviews.

4G.3.1 Andco-Torrax

4G.3.1.1 Degree of Demonstration

Although pyrolysis remains a new and relatively untried method of waste to energy conversion, some European municipalities have invested in the Andco-Torrax Process. Currently, there are four facilities either operating, undergoing startup, or under construction in Europe.

4G.3.1.2 Reliability

Two full-scale commercial facilities have been in continuous operation for a total of 18 months.

4G.3.1.3 Flexibility

According to Andco Incorporated, the smallest practical unit that can be built to pyrolyze solid waste is 100 tons-per-day. A module of this size does not afford the degree of flexibility required for an appropriately sized facility for the City of Berkeley.

4G.3.1.4 Ease of Operation and Maintenance

The Andco-Torrax Process is a high temperature slagging process and, as such, maintenance and operational requirements should be carefully investigated. Although the facilities in Europe have a total of 18 months on line experience, data has not been available on operation and maintenance.

As with any boiler plant, licensed boiler operators are needed. Operators of other equipment, however, need only possess moderate skills on the level necessary to operate conventional fossil fuel-fired boiler plant. Maintenance personnel should be sufficiently skilled to maintain the electrical and mechanical equipment.

4G.3.2 BSP Pyrolyser

4G.3.2.1 Degree of Demonstration

The BSP Pyrolyser Process centers around a multiple hearth furnace. This type of furnace has been utilized to incinerate sewage sludge for over fifty (50) years. However, the

4G.3.2.1 (Continued)

only refuse pyrolysis application occurred in Contra Costa County Sanitary District's pilot project in Concord, California. A two-month test was conducted to demonstrate the feasibility of pyrolyzing sewage sludge with RDF. There are no 100 percent RDF fired BSP units currently under design or construction.

4G.3.2.2 Reliability

While multiple hearth incinerators have demonstrated reliability when incinerating sewage sludge, the lack of experience in combusting RDF makes system reliability uncertain under this application. In addition, this process requires RDF preparation. The discussion of RDF plant reliability is therefore applicable here (refer to Section 4G.3.7.2). Furthermore, the multiple hearth utilizes wet scrubber technology to control gaseous air emissions. Wet scrubbers have not proven successful when utilized to control emission from MSW combustion; therefore, further field data is required to ascertain the effectiveness and reliability of this unit when applied to the BSP Pyrolyser Process.

4G.3.2.3 Flexibility

According to the manufacturer, the smallest practical unit that can be built to pyrolyze solid waste is fifty (50) TPD. Therefore, multiple hearth incinerators lend themselves to modular addition, i.e., a 50 TPD unit may be added to an existing installation when and if additional capacity is required. However, since the multiple hearth system requires RDF, additional capacity is limited to the flexibility of the RDF processing plant (refer to Section 4G.3.7.3).

4G.3.2.4 Ease of Operation and Maintenance

The pilot test was of insufficient duration to adequately assess operation and maintenance requirements. As with any boiler plant, licensed boiler operators are required. Operators of other equipment, however, need only possess moderate skills on the level necessary to operate a conventional fossil fuel fired boiler plant. Maintenance personnel should be sufficiently skilled to maintain the electrical and mechanical equipment.

4G.3.3 Waterwall Combustion Systems - Unprocessed Wastes

4G.3.3.1 Degree of Demonstration

Of all the energy recovery systems considered, combustion of unprocessed wastes in a waterwall incinerator has the longest experience record. This type of system has been utilized in Europe for over twenty (20) years and in the United States for ten (10).

4G.3.3.2 Reliability

The operating experience of Waterwall Combustion Systems in the United States and Europe varies from good to poor. Some units have performed reliably and economically while others due to poor design or operation have exhibited technical or economic problems. These units have encountered some difficulty in combustion performance due to the variability and unpredictability of the incoming wastes. Discussion with plant operators indicate a consensus that some degree of preprocessing would help achieve designed performance.

4G.3.3.3 Flexibility

According to the manufacturers, the smallest practical unit is 200 TPD. Therefore, the modular concept is not appropriate. However, there is some flexibility inherent in the incinerator as it may be operated fairly efficiently at as low as 60 percent of design capacity. It should be noted that operating a system well below its design capacity will significantly increase the cost per ton processed.

4G.3.3.4 Ease of Operation and Maintenance

The mechanical stoking mechanism utilized as a means of firing the waste has proven quite successful. The most favored is the double reciprocating grate which has demonstrated excellent combustion efficiency with a wide range of refuse quality. This stoker seldom fouls and requires minimal maintenance.

The corrosion and abrasion of boiler tubes in these units is not significant at low steam temperatures and pressures. However, at high temperatures where superheat is required, superheater tubes have proven troublesome and are high maintenance components needing costly periodic replacement. New alloys used to construct superheater tubes are currently being tested to minimize or overcome this problem.

As with any boiler plant, licensed boiler operators are required. Operators of other equipment, however, need only possess moderate skills on the level necessary to operate

4G.3.3.4 (Continued)

a conventional fossil fuel fired boiler plant. Maintenance personnel should be sufficiently skilled to maintain the electrical and mechanical equipment.

4G.3.4 Waterwall Combustion Systems - Shredded Wastes

4G.3.4.1 Degree of Demonstration

The equipment utilized to combust shredded wastes is similar to that required for unprocessed wastes. However, the operating experience of waterwall combustion units utilizing 100 percent shredded MSW is limited to a single installation in Hamilton, Ontario. This plant, placed in operation in February 1972, receives an average of 300 to 400 TPD of residential and commercial wastes.

4G.3.4.2 Reliability

Shredding wastes produces a more uniform feed to the combustion zone. This should result in more efficient combustion and steam generation. However, because the Hamilton facility has not been operated to maximize steam production (due to a lack of a steam customer), no technical data is available to support this supposition.

The Hamilton facility has experienced major problems with materials handling both before and after shredding.

4G.3.4.3 Flexibility

The degree of flexibility inherent in this system is similar to that of waterwall systems combusting unprocessed wastes (refer to Section 4G.3.3.3).

4G.3.4.4 Ease of Operation and Maintenance

Operation and maintenance requirements are similar to those waterwall systems combusting unprocessed wastes (refer to Section 4G.3.3.4). Ash handling, however, is simplified since large bulky items are not required to be removed manually from the ash hopper prior to dumping. It should be noted that the shredder which is included in this system is a high maintenance item.

4G.3.5 Waterwall Combustion Systems - Refuse Derived Fuel (RDF)

4G.3.5.1 Degree of Demonstration

RDF combustion is currently limited to operations co-firing RDF as a supplement to coal. There are, however, two large projects (refer to Table 4-1) which are planned which will utilize 100 percent RDF. Equipment utilized to burn RDF would be similar to bark-fired boilers which are in operation in lumber, pulp, and paper mills throughout the country.

4G.3.5.2 Reliability

Comments pertaining to other Waterwall Combustion Systems are applicable to RDF-fired units. However, performance characteristics are expected to improve with the degree of preprocessing. This is due to the more uniform particle size and the removal of many potential slag forming materials.

Three parameters that need attention in a RDF-fired Waterwall Combustion System are as follows:

- Fuel charging system (i.e., a separate RDF receiving and handling mechanism is required).
- Dust and housekeeping problems attributed to RDF handling (requires daily cleanup and dust control equipment).
- Emission of sub-micron particulate matter in stack exhaust (requires careful consideration to control equipment design).

4G.3.5.3 Flexibility

Since this system would incorporate the inflexibility of an RDF processing facility (refer to Section 4G.3.7.3) and the non-modularity of a waterwall combustion unit, it is considered the least flexible of the systems under consideration.

4G.3.5.4 Ease of Operation and Maintenance

The operation and maintenance of this system include those of other waterwall systems (refer to Sections 4G.3.3.4 and 4G.3.4.4) and an RDF processing plant (refer to Section 4G.3.7.4).

4G.3.6 Package Incinerators

4G.3.6.1 Degree of Demonstration

Controlled air package incinerators have been commercially available for over a decade. These units have been predominantly batch-fed without continuous ash removal. Recently, waste heat boilers have been incorporated to allow steam or hot water production from the flue gases. Steam producing units have been in operation since 1975. These units produce saturated steam only. No attempt to produce superheated steam has been made.

4G.3.6.2 Reliability

Early facilities were troubled with such technical problems as:

4G.3.6.2 (Continued)

- Combustion performance.
- Slagging in primary chamber resulting in obstruction of underfire air ports.
- Deterioration of refractory material.
- Tendency of the ram loader to drag back burning material from the primary combustion chamber to the feed hopper.
- Potential fire hazard due to fluid from burst hydraulic lines contacting flame or hot metal surface.

In response to these problems, recent units have incorporated such design features as continuous ash removal and large water-cooled underfire air ports.

The EPA is funding a comprehensive evaluation of the most advanced municipal facility (located in North Little Rock, Arkansas). It is expected that this evaluation will provide definitive data on system reliability.

4G.3.6.3 Flexibility

Package Incinerators with steam producing capability are available in 25 and 50 TPD modules. Therefore, this system offers total flexibility in responding to changes in the waste stream and steam output requirement.

4G.3.6.4 Ease of Operation and Maintenance

Currently operating units require frequent, but not difficult maintenance. Generally, the maintenance required does not interrupt daily operation unless a major repair such as refractory, or component replacement is necessary.

Operation of the plant requires relatively unskilled labor. However, licensed boiler operators are required. Maintenance personnel should be sufficiently skilled to maintain the electrical and mechanical equipment.

4G.3.7 RDF Production Systems

4G.3.7.1 Degree of Demonstration

The first full scale plant to prepare RDF has been in operation in Ames, Iowa since 1975. Subsequently, other plants using similar technology have been designed and constructed across the country. These plants are in varying stages of construction, start up, and operation.

4G.3.7.1 (Continued)

Although there are a number of RDF Production Systems operating or in start up, they are still developmental in terms of process and equipment application. More experience is needed to adequately predict performance and maintenance requirements.

4G.3.7.2 Reliability

Many problems have been identified in the plants with sufficient operating experience; they include:

- Material handling (i.e., receiving, conveying, storage, etc.).
- Shredder hazard and maintenance requirements.
- Equipment configuration.
- Product quality.
- Equipment performance and reliability.
- General housekeeping.

Many of these problems are being solved with the benefit of experience gained from day to day operation of existing facilities. However, adequate RDF storage to avoid bridging and binding has not been fully demonstrated. Erosion of elbows in pneumatic conveying systems is still a major problem along with additional housekeeping chores created by failures at these high wear locations. Additionally, many designs continue to put highly abrasive RDF through material handling fans resulting in frequent replacement of fan blades and housings.

The capacity of RDF processing lines is rated in tons per hour. Manufacturers suggest a minimum operating capacity of 40 tons per hour. Therefore, little redundancy can be built into a facility sized for Berkeley.

4G.3.7.3 Flexibility

Decreased waste quantities can be handled by limiting hours of operation while increased capacity can be accomplished by extending the hours of operation provided sufficient time remains to perform necessary maintenance. It should be noted that operating a system of this type well below its design capacity will significantly increase the cost per ton processed.

4G.3.7.4 Ease of Operation and Maintenance

Performance of an RDF processing line does not require highly skilled operators. However, maintenance personnel should possess mechanical skills necessary to maintain conveyors, shredders and other related equipment.

4H ENVIRONMENTAL IMPACTS

4H.1 Introduction

When energy and material resources are extracted, processed, converted and used, the realted impacts on health and the environment often require that new and increasingly more efficient pollution control methods be used. This section presents potential environmental impacts that might result from implementation of the systems under consideration, and also identifies measures to mitigate these impacts. Table 4-2 summarizes the discussion to follow.

Potential environmental impacts include the internal as well as the external environment of a resource recovery facility. Internal impacts include:

- Dust generation
- Explosion potential
- Noise generation
- Odor generation.

External impacts include:

- Air emissions
- Process wastewater disposal
- Residual disposal
- Facility aesthetics (building and equipment obtrusiveness).

4H.2 Air Quality Impacts

4H.2.1 Dust Generation

First-generation resource recovery facilities have highlighted the need for internal dust control equipment. Any facility receiving and/or processing refuse in any manner will generate dust. Therefore, none of the systems under consideration are immune to dust generation. Process equipment which are considered significant dust generators include: conveyors, shredders, and air classifiers.

TABLE 4-2 POTENTIAL ENVIRONMENTAL IMPACTS

Process	Air		Water	Residuals	Noise	Aesthetics	Explosion Potential	Odor
	Excessive Dust Generation *a	Stack Emissions That Exceed Bay Area Standards	Process Discharge	Hazardous Residuals *e	Excessive Generation *a	Obtrusive Facility and/or Equipment	Potential Hazard to Personnel	Excessive Generation *a
Pyrolysis								
•Andco-Torrax	Yes	*b	Yes	Yes	Yes	Yes	No	Yes
•BSP	Yes	*b	Yes	Yes	Yes	Yes	Yes	Yes
Waterwall Combustion								
•Unprocessed	Yes	*b	Yes	Yes	Yes	Yes	No	Yes
•Shredded	Yes	*b	Yes	Yes	Yes	Yes	Yes	Yes
•RDF	Yes	*b	Yes	Yes	Yes	Yes	Yes	Yes
Package Incinerators	Yes	*c	Yes	Yes	No	No	No	Yes
RDF Production Systems	Yes	*d	No	No	Yes	No	Yes	Yes

*a Internal Impact Only
*b Sufficient Information Not Available
*c State Solid Waste Management Board Is Currently Conducting Test On Such Units
*d Not Applicable
*e Considered Group I Waste By State Water Quality Control Board

4H.2.1 (Continued)

Recently constructed facilities have complete dust collection systems, with fabric filter dust control devices, throughout their plants. Water-mist sprayers for shredding equipment are also being utilized to control dust. At some facilities, workers wear respirators, or other devices, to reduce inhalation of dust as it is thought that most bacteria and virus micro-organisms are attached to dust particles (Reference 11). Daily housekeeping of facility premises is a necessity.

Plants visited during the course of this study did not exhibit detectable dust levels offsite.

4H.2.2 Stack Emissions

Stack emissions can consist of particulates and gases in the form of SO_2, NO_x, HCL, and CO in addition to CO_2, oxygen, water vapor, and hydrocarbons (Reference 12). The Bay Area air pollution emission standards (Reference 13) for pollutants for which standards exist are presented in Table 4-3. Standards currently do not exist for HCL.

The Bay Area Air Pollution Control District (BAAPCD) has promulgated a New Source Review Rule. This rule essentially prevents the issuance of a permit for facilities that emit a total in excess of either 15 pounds per hour (lb/hr) or 150 pounds per day (lb/day) of any contaminant covered by a state or national ambient air quality standard unless it is shown that the facility is constructed using the best available control technology. Furthermore, if the facility emits a total in excess of either 25 lb/hr or 250 lb/day of such contaminants, the facility is subject to an assessment of its impact on the attainment or maintenance of the local air quality. To allow issuance of a permit under these circumstances the assessment would have to show that, as a consequence of system operation, net emissions elsewhere in the basin would be reduced accordingly.

An exception is possible for a facility which represents a significant advance in the development of a technology offering environmental or public health benefits. It is not clear at the present time how the BAAPCD will interpret the rule's exemption provisions. Most suppliers claim that their system can meet federal and any State air emission standards. However, because BAAPCD uses test methods that are difficult than EPA's, test data derived through EPA methods and interpretations can be very

TABLE 4-3

BAY AREA AIR POLLUTION EMISSION STANDARDS *a

POLLUTANT	SOURCE CHARACTERISTIC MEASURED	BAAPCD REGULATION 2
Particulate	Opacity - all sources	20%
	Grain Loading - all sources	.15 gr/SCF
	Incinerators and Salvage >100 TPD	.05 gr/SCFD
	Fossil Fueled Steam Generators*b	.1 lb. per 10^6 BTU
Sulfur Dioxide	All sources at stack	300 ppm
	or at ground level	0.5 ppm for 3 min. 0.04 ppm for 24 hrs.
	Fossil Fueled Steam Generators*b	0.8lb/10^6 BTU Liquid Fuel
	Fossil Fueled Steam Generators*b	1.2lb/10^6 BTU Solid Fuel
	Fossil Fueled Steam Generators*b	0.2lb/10^6 BTU Gaseous Fuel
Nitrogen Oxides	Fossil Fueled Steam Generators*b	0.3lb/10^6 BTU Liquid Fuel
	Fossil Fueled Steam Generators*b	0.7lb/10^6 BTU Solid Fuel
	Fossil Fueled Heat Transfer >250x10^6BTU/hr.	125 ppm gas. fuel 225 ppm liq. fuel
	>1750x10^6BTU/hr.	175 ppm gas. fuel 300 ppm liq. fuel
Organic Gases	Incinerators and salvage	25 ppm hydrocarbons or carbonyls
Hydrogen Sulfide	All sources ground level	.06 ppm 3 min. aver. .03 ppm 1 hr. aver. per 24 hr. day
Odorous Substances*c	Trimethylamine	0.02 ppm
	Phenolic Compounds	5.0 ppm
	Mercaptans	0.2 ppm
	Dimethylsulfide	0.1 ppm
Reactive Organics	Per Regulation 3 of BAAPCD. This regulation is quite lengthy and complex and may apply to certain products of resource recovery operations.	

*a Source Bay Area Air Pollution Control District, Regulation 2, 17th Revision, June 1977.

*b BAAPCD adopted EPA new source performance standards in December 1974 as Regulation 7.

*c Limits for type A emission point (a stack having a straight length six times the significant Dimension L. Type B (all others) limits are one-half those tabulated.

misleading. Furthermore, there is no correlation method allowing conversion of the results of one method to the other (Reference 2).

The State Solid Waste Management Board is pursuing a policy of funding air emission testing in an effort to generate data applicable to California. Tests have been conducted on the waterwall combustion unit utilizing shredded refuse in Ontario, Canada. Due to plant operational difficulties, however, the data collected was inconclusive. The Board is currently funding tests on two package incinerator units (manufactured by Consumat Systems, Inc. and Kelley Company). The Board intends to determine if these units can meet California standards without the aid of air pollution control equipment.

The heterogeneous and varying composition of refuse results in emissions of great inconsistency making control exceedingly difficult but not impossible. Discussions with various resource recovery facility operators indicate a consensus of opinion that the variability in emissions could be reduced by such preprocessing steps as shredding and air classification.

Of the air pollution control equipment used to date, electrostatic precipitators (ESP) have proven the most successful in cleaning up stack emissions, especially particulate generation. Some facility operators expressed the opinion that multicylones preceding ESP's would provide an added safety factor against varying emissions. The BSP Pyrolyser Process is being marketed with a wet scrubber; Package Incinerators are designed to operate without additional air pollution control equipment and the other systems are being marketed with ESP's.

Key element in controlling air emissions, assuming properly designed pollution control equipment, is boiler operation. Depending upon the system, the operator has control of under and overfire air, auxiliary fuel burners, and stoker speed. Proper control of these variables can eliminate much of the fluctuating air emission problems that occur due to the varying composition of refuse.

4H.3 Water Quality Impacts

The only significant water usage, other than for steam generation, occurs in ash quenching. Water quenching of ash from boilers and reactors is usually necessary to cool burning materials and prevent fires in ash storage receptacles. Quench water from Waterwall Combustion Units, Package Incinerators, and the Andco-Torrax Process is progressively removed in the wet ash with a relatively small overflow to the sewer. In the BSP Pyrolyser Process, quench water is utilized to transport slurried ash to settling tanks. Tank effluent is recirculated through the stack scrubber and then back to the ash quenching tank with some overflow to the sewer.

4H.3 (Continued)

All systems with boiler equipment generate periodic boiler blowdown. This wastewater flow requires neutralization prior to discharge to the sewers.

Because the RDF production systems under consideration are "dry" processes, no process wastewater is expected from such systems.

4H.4 Residuals

Solid waste, intrinsically, has an ash content; that is, some of the waste is noncombustible. Even the waste that will burn will not combust completely. Paper, for example, is about eight (8) percent ash. During burning, part of the ash component of refuse rises with the hot gases of combustion (fly ash) and part falls to the bottom of the combustion chamber (bottom ash). The completeness of combustion, and hence the amount of ash, is also a function of the type and efficiency of the combustion process.

At present, the California Water Quality Control Board considers bottom ash and fly ash as Group I Wastes requiring disposal in either Class I or Class II-1 disposal sites. However, site specific tests might prove the ash nonhazardous and disposal in a Class II landfill would then be permitted.

Pyrolytic slag from the Andco-Torrax Process is claimed by its manufacturer to be inert and nonleaching. Use as a construction aggregate may therefore be possible.

Process residuals from an RDF plant depending on the level of processing could include glass, dirt, metals, ceramics, and some organics. This waste can be disposed of in Class II landfills.

4H.5 Noise Impacts

Noise level measurements that have been made inside resource recovery facilities have exceeded 90 decibels (Reference 12). In most cases, these levels do not occur where operators would be subjected to them for periods exceeding those prescribed by Occupational Safety and Health Administration (OSHA) regulations. Equipment which are considered significant noise generators include: large, high speed fans; shredders; and crawler tractors. In those cases where an operator would be subjected to excessive levels over extended periods of time, ear protection devices have proven to be sufficient mitigating equipment.

Facilities visited during the course of this study did not have detectable noise outside of the facilities.

4H.6 Aesthetics

The Waterwall Combustion Systems and the pyrolysis processes under consideration are housed in large buildings resembling fossil fuel power plants, often reaching heights in excess of 100 feet. The

emissions stack and the air pollution control device(s) are usually located outside the building.

The air classifier equipment is generally the tallest piece of equipment on-site at an RDF production facility and may project above the roofline. On the whole, an RDF production facility has a low profile common to industrial manufacturing buildings.

The building housing Package Incinerators resembles an RDF Production facility except that emission stacks rather than the air classifier will project above the roofline.

4H.7 Explosion Potential

All energy recovery systems under consideration which require RDF or shredded refuse as the input fuel source will be susceptible to explosions if refuse processing and/or storage is conducted on the same site.

The possibility of fires and dust and shredder explosions in RDF Production Facilities requires careful placement of suppression and control devices throughout the dry processing systems. A recent study by Factory Mutual Research Corporation (Reference 14) reported that:

- Shredder explosions are numerous.
- Damage and injury potential is limited by the structural integrity of the shredder.
- Causes of explosions vary and are often difficult to identify.
- Materials identified as having caused explosions are common flammable gases or vapors (gasoline, propane, paint, thinner, etc.), commercial or military explosives (dynamite, gunpowder, etc.) and combustible dust.

The recommended mitigating measures included in the report were:

- Manually screen input materials.
- Use a continuous water spray within the shredder to protect against flammable vapor and dust explosion. This spray would also provide a valuable fire protection measure.
- Use ducts for channeling vented shredder gas out of the building.
- Utilize explosion suppression systems such as Halon.

4H.7 (Continued)

Second generation facilities are implementing these recommendations in addition to constructing walls around the shredder for added protection and noise suppression.

Mitigating measures to control dust buildup have already been discussed in Section 4H.2.1. Water sprinkling systems have been installed over refuse receiving and storage areas as a fire protection measure.

4H.8 Odor Impacts

All facilities handling refuse will generate a certain amount of odor. Odor generation can be reduced by:

- Good housekeeping practices (daily sweeping and a minimum of weekly steam cleaning of floors, walls, and accessible equipment).

- Periodic deodorizing.

- Drawing combustion air from inside the building.

Facilities visited during the course of this study did not have malodors outside of the facilities.

4I ENERGY CONSIDERATIONS

4I.1 Introduction

Since the primary objective of the systems under consideration is to utilize the heating value of refuse to produce a useable energy product, it is important to consider each system's energy production effectiveness. In this Section, the net system output (defined as the initial energy value of the refuse less system energy requirements and heat losses) is presented. In addition, the energy productivity ratio (defined as the ratio of the net system output to the original energy value of the refuse) is presented for purposes of system comparison. The higher the ratio the more efficient the system.

4I.2 Assumptions

In order to develop the net system output for each system on a comparison basis, the following assumptions were made:

- Net system output is calculated from the point that the refuse enters the processing facility through the production of steam (or in the case of RDF Production, through the point where the RDF is converted to steam at the off-site conversion facility).

4I.2 (Continued)

- Incoming refuse has an energy value of 4,500 BTU per pound.
- RDF will be transported thirteen (13) miles* (requiring 26 round-trip miles) for conversion in a semi-suspension boiler.
- Residuals will be transported 52 miles for disposal at Acme Fill Landfill.
- Energy requirements of mobile equipment utilized at the SWMC are negligible.

4I.3 Net System Output

The net system output can be calculated by deducting from the original energy value of the refuse all process energy requirements and system losses. Process energy requirements include (as appropriate):

- Electricity required to operate the refuse fuel processing plant.
- Fossil fuel and electricity required to operate the energy conversion facility.
- Fossil fuel required to transport RDF.
- Fossil fuel required to transport residues to disposal site.

System losses include (as applicable):

- Loss of combustible material during refuse fuel processing.
- Heat losses during energy conversion.

Table 4-4 summarizes the net system output for each of the systems under consideration on the basis of one pound of refuse. In addition, the energy productivity ratio is calculated and shown.

4I.4 System Comparison

For purposes of comparison, the systems are ranked according to energy production effectiveness as follows:

System	Energy Production Ratio
• Waterwall Combustion Unprocessed Refuse	60%
• Andco-Torrax	57%
• Package Incinerators	54%
• Waterwall Combustion of Shredded Refuse	52%
• Waterwall Combustion of RDF	48%
• RDF Production	48%
• BSP Pyrolyser	44%

* Equal to the distance from the Gilman Street Site to the proposed City of Alameda Resource Recovery Facility.

CHAPTER 5

ECONOMIC ANALYSIS

TABLE 4-4 ENERGY PRODUCTIVITY OF RESOURCE RECOVERY SYSTEMS

	Andco-Torrax	BSP Pyrolyser	Waterwall Combustion Unprocessed	Waterwall Combustion Shredded	Waterwall Combustion RDF	Package Incinerators	RDF Production
A. Energy Input (BTU Per Pound Refuse)	4,500	4,500	4,500	4,500	4,500	4,500	4,500
B. Energy Requirements and Losses (BTU Per Pound Refuse)							
• Refuse Fuel Processing							
• Electrical Requirements	--	240	--	190	240	--	240
• Loss of Combustibles	--	900	--	680	900	--	900
• Energy Conversion Facility	250	90	120	120	70	330	70
• Fossil Fuel and Electrical Requirements							
• Heat Loss	1,690	1,250	1,670	1,160	1,110	1,710	1,110
• Transportation							
• Residues	10	20	10	20	20	10	20
• Refuse Derived Fuel	--	--	--	--	--	--	10
Total	1,950	2,500	1,800	2,170	2,340	2,050	2,350
C. Net System Output (BTU Per Pound Refuse) (A minus B)	2,550	2,000	2,700	2,330	2,160	2,450	2,150
D. Energy Productivity Ratio (C divided by A)	57%	44%	60%	52%	48%	54%	48%

5A INTRODUCTION

In order to compare the resource recovery alternatives under consideration in terms of potential for cost effective operation, a relative cost analysis was performed. Capital and operating costs are presented in Section 5B. Markets for recovered energy products are discussed in Section 5C. Market revenues to be generated from the sale of recovered products are presented in Section 5D; annual net systems costs are computed in 5E; and the economic impact of source separation on the least cost system is evaluated in Section 5F.

5B CAPITAL AND OPERATING COSTS

Capital and operating costs, based on manufacturers' data and previous reports are presented in Table 5-1. Costs for RDF Production and Site Development were obtained from the Berkeley Phase One Study (Reference 1) and were escalated at ten (10) percent to 1978 prices. Refuse Fuel Storage costs were obtained from an earlier G•E•Z•R report (Reference 15) conducted for Humboldt County in which co-disposal of RDF and woodwastes in woodwaste boilers was investigated. These costs were also escalated at ten (10) percent to 1978 prices. Energy Recovery System costs were developed from manufacturers' estimates. A twenty (20) percent contingency was added to cover site specific conditions. Also added to manufacturers' estimates were a one-mile steam line (at an estimated capital cost of $200,000), and five (5) percent of capital expenditures for finance related costs. Operating costs for residual disposal are based on the assumption that the ash (both bottom and fly ash) from these systems can be disposed at a Class II-1 landfill.

The estimated cost of the systems under consideration are summarized below. It should be noted that these are total costs and do not reflect system revenues.

System	Annual Cost	Total Cost Per Ton
• Andco-Torrax	$ 3,060,000	$ 48
• BSP Pyrolyser	2,750,000	43
• Waterwall Combustion		
• Unprocessed	2,760,000	43
• Shredded	3,730,000	58
• RDF	3,470,000	54
• Package Incinerator	1,540,000	24
• RDF Production	1,610,000	25

5C MARKETS FOR RECOVERED ENERGY PRODUCTS

The following is a list of firms and institutions which have expressed interest in purchasing refuse derived steam the majority of which are located within a one mile radius from the Gilman Street Site:

- McDermott Meat
- O. L. King
- Cal Ink

TABLE 5-1 RELATIVE CAPITAL, OWNING AND OPERATING COSTS *a OF RESOURCE RECOVERY SYSTEMS

	Andco Torrax	BSP Pyrolyser	Waterwall Combustion Unprocessed	Waterwall Combustion Shredded	Waterwall Combustion RDF	Package Incinerators	RDF Production
CAPITAL COST							
• Refuse Fuel Production*b	--	$6,200,000	--	$5,600,000	$6,200,000	--	$6,200,000
• Refuse Fuel Storage*c	--	1,200,000	--	1,200,000	1,200,000	--	--
• Energy Recovery System*d	$17,800,000	4,200,000	$16,100,000	11,400,000	8,700,000	$6,200,000	--
• Site Development*b	400,000	400,000	400,000	400,000	400,000	400,000	400,000
TOTAL	$18,200,000	12,000,000	$16,500,000	$18,600,000	$16,500,000	$6,600,000	$6,600,000
ANNUAL OWNING COST							
(at 6%, 20 years)	$1,590,000	$1,050,000	$1,440,000	$1,620,000	$1,440,000	$ 580,000	$ 580,000
OPERATING COST							
• Refuse Fuel Production*b	--	$1,030,000	--	$ 590,000	$1,030,000	--	$1,030,000
• Refuse Fuel Storage*c	--	50,000	--	50,000	50,000	--	--
• Energy Recovery System*e	$1,470,000	620,000	$1,320,000	1,470,000	950,000	$ 960,000	--
TOTAL	$1,470,000	$1,700,000	$1,320,000	$2,110,000	$2,030,000	$ 960,000	$1,030,000
TOTAL ANNUAL COST	$3,060,000	$2,750,000	$2,760,000	$3,730,000	$3,470,000	$1,540,000	$1,610,000
COST PER TON*f	$ 48	$ 43	$ 43	$ 58	$ 54	$ 24	$ 25

*a Relative costs were obtained from manufacturers' estimates and previously published studies.
*b Reference 1 costs escalated at ten (10) percent to 1978 prices.
*c Reference 15 costs escalated at ten (10) percent to 1978 prices.
*d Manufacturer's estimate plus twenty (20) percent contingency; plus $200,000 for a one (1) mile eight-inch steam line plus five (5) percent for finance related costs. Includes buildings, utilities and startup costs.
*e Manufacturers' estimates plus twenty (20) percent contingency. Includes labor, maintenance, utilities, residual disposal.
*f Annual tonnage 64,400.

5C (Continued)

- Manasse Block Tanning
- De Soto, Inc.
- U.S.D.A. Western Regional Lab
- Pacific Gas and Electric Company
- Colgate Palmolive Company
- Cetus Corporation
- Jeriflo Corporation
- Magic Candle Company.

In addition, the State Department of Water Resources has indicated interest in participating in waste-to-energy projects of this scale.

The City of Alameda has indicated interest in purchasing RDF.

5D PROJECTED SYSTEM REVENUES

5D.1 Steam

All systems under consideration, with the exception of the production and off-site sale of RDF, involve the production of steam. The annual quantity of steam produced is given by

$$\frac{64{,}400 \text{ Tons MSW}}{\text{Year}} \times \left(9 \times 10^6 \frac{\text{BTU}}{\text{Ton/MSW}}\right) \times \left(\frac{1 \text{ lb. steam}}{1{,}084 \text{ BTU*a}}\right) \times F_A \times F_B \times F_C$$

where

F_A = Energy efficiency of refuse fuel processing (where applicable) = (.55 Tons RDF) x (13 x 10^6 BTU/Ton) ÷ (1 Ton MSW) x (9 x 10^6 BTU/Ton) = .80,

F_B = Boiler efficiency,

F_C = Percent of normal operating time that the facility is expected to be on-line = .85.

The annual outputs for the steam producing systems under consideration are as follows:

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*a Based on 300 psi saturated steam

5D.1 (Continued)

System	F_A*b	F_B	Annual Pounds Steam
• Andco-Torrax	1	.60*c	273×10^6
• BSP Pyrolyser	.80	.65*d	237×10^6
• Waterwall Combustion			
• Unprocessed	1	.59*e	268×10^6
• Shredded	1	.64*f	291×10^6
• RDF	.80	.69*e	251×10^6
• Package Incinerator	1	.69*g	314×10^6

The current market value of steam is $0.003 per pound. Therefore, the annual steam revenue from each system is as follows:

• Andco-Torrax	- (273×10^6) lbs. steam	x $ .003	= $819,000
• BSP Pyrolyser	- (237×10^6)	x $ .003	= $713,000
• Waterwall Combustion			
• Unprocessed	- (268×10^6)	x $ .003	= $804,000
• Shredded	- (291×10^6)	x $ .003	= $873,000
• RDF	- (251×10^6)	x $ .003	= $753,000
• Package Incinerators	- (314×10^6)	x $ .003	= $942,000

5D.2 RDF

The market value of RDF has been estimated to range from $17.50 to $25.00 per ton.*h Economic analyses in the Phase One report used $14.60 (75 percent of the price of coal on an energy basis) as a conservative value. The City of Alameda, however, has stated that it would consider paying only $7.00 per ton for RDF delivered to its facility. For the purposes of this analysis, the $7.00 figure is used.

The net market value of the RDF is $4.30 per ton ($7.00 minus $2.70*i). The annual revenue derived is $149,000 (34,600*j tons x $4.30/ton).

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*b Np = 1, where there is no RDF production
*c Reference 15
*d Reference 6
*e Reference 5
*f No data available. Assumed to be midway between F_B for combusting unprocessed wastes and RDF
*g Based on field observation at North Little Rock, Arkansas facility
*h Reference 16
*i Haul cost to Alameda from Table B-1
*j Reference 1

5D.3 Secondary Materials

The systems under consideration recover marketable materials in varying degrees. Annual quantities recovered and revenues generated are discussed below.

Each system which utilizes a tipping floor for receiving the wastes (Waterwall Combustion of shredded wastes and RDF, Package Incinerators, and RDF Production) offers the opportunity to manually recover cardboard. In the Phase One Report it was established that 1,050 annual tons of cardboard with a net market value of $12 per ton (unbaled) could be recovered in this manner. This equates to approximately $13,000 annual revenue.

Those systems incorporating RDF production (BSP, Waterwall Combustion of RDF and RDF Production) could reclaim an additional 510 tons of cardboard annually at a post-trommel picking station (Reference 1). This equates to an additional $6,000 annual revenue.

Systems incorporating shredding (BSP, Waterwall Combustion of shredded wastes and RDF, and RDF Production) include the provision for recovering ferrous metals prior to combustion. The Phase I Report reported that 3,120 tons of ferrous with a net market value of $23.00 per ton could be recovered in this manner. This equates to $72,000 annual revenue.*

5D.4 Total Revenues

The total projected revenue for each system is given as follows:

	Annual	Per Incoming Ton
• Andco-Torrax	$819,000	$13.00
• Bsp Pyrolyser	$804,000	$13.00
• Waterwall Combustion		
• Unprocessed	$804,000	$13.00
• Shredded	$964,000	$15.00
• RDF	$844,000	$13.00
• Package Incinerators	$955,000	$15.00
• RDF Production	$240,000	$ 4.00

These revenue estimates are displayed in Table 5-2.

5E ECONOMIC COMPARISON OF SYSTEMS

Net costs are defined as the owning and operating costs (established in Section 5B) less system revenues (established in Section 5D). Net costs on an annual and per ton basis are presented below. The systems (including the least cost existing disposal alternative identified in Section 3E.4) are ranked in order of least cost.

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* Andco-Torrax and Package Incinerators do not incorporate shredding. However, if pretrommeling is incorporated to improve the combustion characteristics of the solid fuel, ferrous metals may be recovered through a magnetic removal system.

TABLE 5-2 ANNUAL SYSTEM REVENUES

	ANDCO TORRAX	BSP PYROLYSER	WATERWALL COMBUSTION			PACKAGE INCINERATOR	RDF PRODUCTION
			UNPROCESSED	SHREDDED	RDF		
Steam	$819,000	$713,000	$804,000	$873,000	$753,000	$942,000	--
RDF	--	--	--	--	--	--	$149,000
Cardboard	--	19,000	--	19,000	19,000	13,000	19,000
Ferrous	*a	72,000	--	72,000	72,000	*a	72,000
TOTAL Annual Revenue	$819,000	$804,000	$804,000	$964,000	$844,000	$955,000	$240,000
Revenue Per *b Incoming Ton	$ 13	$ 13	$ 13	$ 15	$ 13	$ 15	$ 4

*a Ferrous metals may be recovered through preprocessing steps.

*b Based on 64,400 tons per year.

System	Annual Net Cost	Net Cost Per Ton
• Package Incinerators	$ 585,000	$ 9.00
• Transfer/Long Haul to Acme Fill Company's Landfill	$1,317,000	$20.00
• RDF Production	$1,370,000	$21.00
• BSP Pyrolyser	$1,946,000	$30.00
• Waterwall Combustion (Unprocessed)	$1,956,000	$30.00
• Andco-Torrax	$2,241,000	$35.00
• Waterwall Combustion (RDF)	$2,626,000	$41.00
• Waterwall Combustion (Shredded)	$2,766,000	$43.00

5F ECONOMIC IMPACT OF SOURCE SEPARATION ON LEAST COST SYSTEM

A Package Incinerator System is compatible with on-site recovery of ferrous materials. This could be accomplished by inclusion of pre-processing steps such as trommeling and a magnetic ferrous removal system. However, if recovery of significant quantities of glass and cans is to be part of the City's resource recovery program, a source separation program including a Curbside Collection Program and City-wide Recycling Center is required. A further advantage of the source separation program is that paper products are allowed to be directly converted to new products, rather than burned for its energy value. This allows significant environmental benefits.

Based on the costs of these programs reported in the Phase One Study and the effects of removal of combustibles from the waste stream, operating a parallel source separation program is expected to increase annual costs by $284,000 ($4 per ton) (refer to Appendix H). With a subsidy of capital and/or operating expenses (through the use of CETA employees, SB 650 funding, etc.), a significant reduction in these costs could be achieved.

CHAPTER 6

RECOMMENDATIONS

It is recommended that the City pursue development of a Package Incinerator System producing saturated steam. Consideration should be given to some preprocessing of the refuse prior to incineration (perhaps trommelling) to improve combustion, reduce supplemental fuel requirements and ash production, and permit the recovery of ferrous metals. A proposed implementation workplan is presented in Appendix C. The suggested tasks include:

- Confirmation of markets for recovered products;
- Identification of regulatory agency requirements and environmental constraints;
- Preparation of preliminary design and budget cost estimates;
- Development of a financing and institutional arrangements package;
- Establishment of an implementation masterplan;
- Preparation of Request for Proposal documents and evaluation criteria.

Selection of this system for further consideration is based on the preceding analyses as summarized below:

- Technical

Package Incineration technology is established. Recent improvements in the equipment, the redundancy of modular component and the operating experience of plants such as the North Little Rock Northshore Energy Facility, allows the steam production modules to be considered reliable. Of all the systems under consideration, this is the simplest to operate and maintain.

- Environmental

Two currently unanswered environmental questions remain which are common to all the systems (indirectly with respect to RDF Production) - air pollution and classification of residuals (fly and bottom ash). The analyses being conducted by EPA and the State Solid Waste Management Board on the Package Incinerator System in North Little Rock, Arkansas, are expected to supply the required data to resolve these issues. At present, the California Water Quality Control Board considers fly and bottom ash as Group I Wastes requiring disposal in either Class I or II-1 disposal sites. There are no other unmitigable environmental impacts with this system.

• Cost

The projected economics of the Package Incinerators indicate that it is the most cost effective system ($9.00 per ton of MSW). Even if the estimates are low by 100% (which is extremely unlikely), this system is less expensive than transfer/haul ($20.00 per ton MSW) or the next best energy recovery alternative (RDF Production - $21.00 per ton MSW).

• Energy

The Package Incinerator System ranks third in terms of energy productivity. The slightly lower Energy Production Ratio is not considered sufficient to offset the increased costs of the more efficient systems.

APPENDIX A

REFERENCES

APPENDICES

APPENDIX A - REFERENCES

Reference No.

Reference No.	
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4	Steven J. Levy and Stephen A. Lingle, "A Review of Energy Recovery Technologies," Waste Age, November 1976.
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10	Evaluation of Small Modular Incinerators in Municipal Plants - Ross Hoffman Associates, EPA Contract 68-01-3171, 1976.
11	J. R. Holloway, "EPA Resource Recovery Demonstration: Summary of Air Emissions Analyses, "Waste Age," August 1976.
12	Midwest Research Institute, Environmental Assessment of Waste-To-Energy Processes, Source Assessment Document, April 1977.

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15	Bechtel, Edison-Coordinated Joint Regional Solid Waste Energy Project, April 1977.
16	"Rochester Resource Recovery Plant Nears Completion," Solid Waste Management, June 1978.
17	Peter Chiu and Luis Diaz, Development of a Solid Waste Transfer Station in the City of Berkeley, June 6, 1975.

LOCATION OF WORK PLAN ELEMENTS IN FINAL REPORT

WORK PLAN PART/TASK	TITLE	LOCATION IN FINAL REPORT
A	COLLECT DATA AND ESTABLISH PROJECT DIRECTION	
A1	Confirm Goals and Objectives	1A.2
A2	Confirm Type, Sources, and Quantities of Waste Materials	2A
B	ESTABLISH DISPOSAL ALTERNATIVES	
B1	Identify Alternatives	3B & 3C
B2	Estimate Disposal Costs	3E
B3	Determine Energy Requirements	3F
B4	Identify Environmental Problems	3G
C	INVESTIGATE "LIGHT FRACTION" MARKET CONDITIONS	Deleted from Contract
D	ASSES POTENTIAL FOR TECHNICAL, ECONOMIC, AND ENVIRONMENTAL FEASIBILITY	
D1	Identify Systems With Definite Markets	4A
D2	Appraise Technical Aspects of Identified Systems	4G
D3	Identify Potential Environmental Problems and Mitigating Measures	4H
D4	Prepare Preliminary Cost Estimate of Promising Systems	5B
D5	Compare Market Value With Updated Production Costs	5E
D6	Calculate Net Energy Production of Promising Systems	4I
D7	Prepare Appraisal of Proceeding to Subsequent Stages of Investigation	6

APPENDIX B

WORK PLAN - PHASE II

APPENDIX B

RECOVERY AND DISPOSAL OF SOLID WASTE MANAGEMENT CENTER RESIDUES

PROPOSED SITE SPECIFIC FEASIBILITY STUDY

CITY OF BERKELEY, CALIFORNIA

WORK PLAN

September 30, 1977

PHASE I PRELIMINARY ALTERNATIVES SCREENING

PART A COLLECT DATA AND ESTABLISH PROJECT DIRECTION

Task A1 Confirm Goals and Objectives

Confirm goals and objectives of City and the State Solid Waste Management Board in developing a resource recovery system so as to provide basic direction to study.

Task A2 Confirm Type, Sources, and Quantities of Waste Materials

Utilizing available information, establish types, compositions, and quantities of waste materials, subsequent to multimaterial source separation, that are suitable for further resource recovery processing. Establish effect on waste stream of potential waste reduction measures. Supplement current study findings with a survey of industrial wastes. Establish quantities of processible wastes from neighboring communities which are potentially available to the City for resource recovery. Recommend design parameters.

PART B ESTABLISH DISPOSAL ALTERNATIVES

Task B1 Identify Alternatives

Identify disposal (as opposed to recovery) options available to the City. Include the delivery of unprocessed refuse to:

- City of Alameda
- Vasco Road
- Richmond Landfill
- Oakland Scavenger Company's Transfer Station

- Oakland Scavenger Company's Landfills (Altamont Pass)
- Acme Fill Corporation's Landfill
- Others identified during course of study
- U. S. Steel (Pittsburgh)

Task B2 Estimate Disposal Costs

Estimate probable drop charge requirements and transportation costs associated with each. Establish most economical disposal alternative.

Task B3 Determine Energy Requirements

Determine energy required for refuse haul and disposal under the most economical alternative (see above).

Task B4 Identify Environmental Problems

Identify environmental problems associated with the most economical disposal alternative. Include:

- Dust
- Vehicle emissions
- Other significant impacts

~~PART C INVESTIGATE "LIGHT FRACTION" MARKET CONDITIONS~~*a

PART D ASSESS POTENTIAL FOR TECHNICAL, ECONOMIC, AND ENVIRONMENTAL FEASIBILITY

Task D1 Identify Systems with Definite Markets

Based on preceding market findings, identify appropriate scale resource recovery systems which produce marketable products. Include systems which have not yet been demonstrated on a full scale basis. Consider:

- New and reconditioned solid fuel boilers.
- Small modular steam producing incinerators.
- New and reconditioned turbine generators.
- Pyrolysis systems.
- Fiber recovery systems.

*a Deleted from contract.

- Biogassification.
- Composting.
- Others identified during course of study.

Propose for further consideration those systems for which a market has been identified.

Task D2 Appraise Technical Aspects of Identified Systems

Investigate technical aspects of systems identified above. Identify problems, failures, and/or successes for each type. Assess reliability and risk associated with each. Include field investigations when applicable. Recommend for further consideration those systems which appear technically feasible.

Task D3 Identify Potential Environmental Problems and Mitigating Measures

Assess, in a preliminary manner, the remaining systems' impact on the environment. Include the following aspects:

- Air quality.
- Water quality.
- Residue disposal.
- Water consumption.
- Noise levels.
- Transportation.
- "Light Fraction" product.
- Employment.

Recommend for further consideration those systems which appear environmentally acceptable. Identify systems' pollution control equipment requirements.

Task D4 Prepare Preliminary Cost Estimate of Promising Systems

Based on previous reports on existing installations, manufacturers' data, etc., prepare preliminary capital, operating, and maintenance cost estimates. Calculate production cost of end products.

Task D5 Compare Market Value With Updated Production Costs

Compare estimated market value of the various possible products with the costs to produce them. Compare net cost / revenue with alternate disposal costs established. Recommend for further investigation those systems which demonstrate a sound potential for economic viability.

Task D6 Calculate Net Energy Production of Promising System(s)

Utilizing systems analysis techniques, develop a preliminary energy balance which establishes the relative energy output of the remaining systems. Consider effect of potential waste reduction measures on system output.

Task D7 Prepare Appraisal of Proceeding to Subsequent Stages of Investigation

Based on preceding preliminary investigations, recommend either:

- One or more systems for detailed study, or
- change of study direction, or
- termination of study.

Task E Furnish Reviews and Reports

E.1 Attend Meetings

Periodically meet with the Department of Public Works and Solid Waste Management Commission. Present findings to date and receive and discuss review comments.

E-2 Prepare Draft Final Report

Prepare draft final report summarizing information developed. Submit appropriate system drawings, cost and revenue estimates, and narrative description. Summarize conclusions and recommendations. Append supporting data and documentation.

E-3 Prepare Final Report

Revise draft final report as required to produce a document suitable for printing.

APPENDIX C

PROPOSED WORK PLAN - PHASE III

APPENDIX C

PROPOSED WORK PLAN - PHASE III

PART A CONFIRM MARKETS FOR RECOVERED PRODUCTS

Task A1 Establish Specific Market Terms, Conditions, and Product Specification Requirements

For each potential customer, identify the terms and conditions which may be offered or required for purchase of energy product and secondary materials. Discuss with each contractual possibilities (including joint ventures), floor and market price arrangements, length and degree of commitments, and guarantees. Establish required product specifications.

Task A2 Request Letter of Intent

Develop a model Letter of Intent (LOI) to purchase reclaimed materials and energy. Request submittal of a Letter of Intent from appropriate potential customers.

Task A3 Establish Revenue from Sale of Recovered Products

Based on the above marketing data, calculate estimated revenue from sale of recovered products.

PART B IDENTIFICATION OF REGULATORY AGENCY REQUIREMENTS AND ENVIRONMENTAL CONSTRAINTS

Task B1 Compile Agency Standards and Regulations

Identify agencies having regulatory authority over various elements of this project, including:

- State and local Air Pollution Control Boards.
- State and Regional Water Quality Control Boards.
- State Solid Waste Management Board.
- State and local Health Departments.
- Other.

List and describe applicable standards and regulations by agency.

Task B2 <u>List Regulatory Clearances</u>

Determine steps to be taken to clear impediments and satisfy agency requirements for project implementation.

Task B3 <u>Evaluate Environmental Problems</u>

Review and evaluate available test data pertaining to air pollution emissions and ash disposal. Compare magnitude of potential impacts with degree of control reasonably attainable through mitigating measures. Contact key regulatory agencies and prepare assessment of the probability of obtaining all required permits.

PART C PREPARE PRELIMINARY DESIGN AND BUDGET COST ESTIMATE

Task C1 <u>Develop Conceptual Design(s)</u>

Develop conceptual designs for Package Incineration as follows:

- Relate product specifications to processing methods.
- Investigate requirements for waste storage and presegregation.
- Estimate quantities and types of reclaimed product(s) and process residues.
- Consider storage and transmission requirements for for recovered product(s).
- Establish general arrangement and layout of equipment.
- Determine requirements for space, structures, and utilities.
- Evaluate potential for modular or other types of expansion, if any.
- Integrate system with proposed Gilman Street Site development.
- Produce conceptual design drawings and site plan.
- Prepare outline specifications.
- Prepare narrative description.
- Identify required staffing.

Task C2 Assess Suitability of Gilman Street Site

Assess suitability of Gilman Street Site to the recommended system and markets. Locate additional adjacent property, if necessary.

Task C3 Prepare Budget Cost Estimate

Prepare budget capital cost estimate. Identify necessary associated expenses such as legal and financing charges, startup and training, working capital, and engineering fees. Prepare operating cost estimate, including labor, utilities, maintenance, transportation, replacement reserves, insurance, etc. Determine cost savings by utilizing alternative sites, if any.

PART D DEVELOP FINANCING AND INSTITUTIONAL ARRANGEMENTS PACKAGE

Task D1 Prepare Estimated Costs Summary

Prepare a summary of public and/or private capital and operating costs.

Task D2 Prepare Anticipated Revenue Summary

Prepare a similar summary of anticipated revenues.

Task D3 Prepare Cash Flow Projections

Prepare cash flow projections covering the planning period.

Task D4 Develop Economic Comparisons

For purposes of comparison, calculate significant economic indicators such as drop-charge requirements, power production cost, present worth, return on investment and payback period, based on stipulated interest and inflation rates.

Task D5 Explore Financing Methods and Sources

Explore methods and sources to provide for financing needed capital expenditures and anticipated operating deficits, if any. Report findings in writing.

Task D6 Recommend Financing Methods and Sources

Prepare written report recommending preferred and alternate financing methods and sources, stating reasons for selection. Describe detailed procedures and schedules to be followed to secure necessary financing. Include recommended alternate method and source, if any, and provide for staged construction. Provide interim

consultation and financial guidance, as engineering development of system proceeds, in order to enhance likelihood of funding.

Task D7 Institutional Arrangements

Explore and make recommendations regarding institutional arrangements to implement the solid waste energy recovery system. Consider interface of public and private sector.

PART E ESTABLISH IMPLEMENTATION MASTER PLAN

Integrate recommended system with Transfer/Processing Facility development as staged in the Phase One Study. Develop an overall master plan for implementing the project, as follows:

- Identify remaining steps to implement project.
- Outline remaining decision points and their ramifications.
- Prepare critical path schedule establishing target dates for remaining tasks.

PART F PREPARE REQUEST FOR PROPOSAL DOCUMENTS AND EVALUATION CRITERIA

Task F1 Prepare Request for Contractor Qualifications - Step 1

Prepare document requesting qualifications of potential contractor's organization. Establish evaluation criteria.

Task F2 Prepare Request for Technical Proposals - Step 2

Prepare document requesting technical proposals from Step 1 pre-qualified bidders. Establish evaluation criteria.

Task F3 Prepare Price Bid Document - Step 3

Prepare document requesting price bids from Step 2 pre-qualified bidders.

PART G ATTEND MEETINGS AND PREPARE REPORTS

- Attend Periodic Review Meetings

  Attend periodic project review meeting. Present findings, to date, to representatives of the Public Works Staff, Solid Waste Commission, State Solid Waste Management Board, and other appropriate persons.

- Prepare Draft Task Reports

  At the conclusion of each task, as established by this work plan, prepare a draft task report detailing work completed, methodology used, findings, etc. Include data in tabular form and graphic representations where appropriate. Distribute progress reports monthly for client review.

- Prepare Project Introduction and Summarize Key Findings

  Upon completion of all tasks, prepare an introduction to the project and summarize all significant assumptions, conclusions, and recommendations.

- Prepare Draft Final Report

  Revise draft task reports as necessary. Compile approved task reports into draft final report. Include introduction and summary. Submit draft for client review.

- Prepare Final Report

  Revise and edit draft final report as required to produce a document suitable for printing.

APPENDIX D

INDUSTRIAL WASTE SURVEY

APPENDIX D - INDUSTRIAL WASTE SURVEY

Prepared by

Terry D. Harrison, Consultant

with assistance from

GARRETSON•ELMENDORF•ZINOV•REIBIN
ARCHITECTS AND ENGINEERS

D1 INTRODUCTION

In the Phase One Study, industrial wastes generated in Berkeley were assumed to be disposed of at the Richmond Landfill and therefore not immediately available for processing at the SWMC. If the Richmond Landfill were to close, this waste might require disposal at the SWMC. It was deemed prudent, therefore, to investigate the types and quantities generated.

The purposes of the investigations were to determine:

- Types and quantities of general refuse (nonhazardous) and its disposal locations.
- Types and quantities of this waste suitable for processing at the Transfer Station.
- Types and quantities of materials suitable for recycling through source separation techniques.
- Types and quantities of hazardous waste and its disposal locations.

D2 METHODOLOGY

D2.1 Nonhazardous

The investigation was conducted through a mail survey. A copy of the survey form, cover letter and mailing list is included as Attachment I to this report. The mailing list was derived from a printout of business license holders obtained from the Berkeley Finance Department. The President of the Berkeley-Albany Industries Association was informed of the survey and was very helpful in obtaining cooperation from the membership.

The industries in Berkeley were divided into nine major groups by SIC (Standard Industrial Classification) codes. Replies were tabulated by SIC codes and by the number of employees to determine which groups of industries were well represented. Phone calls were made to solicit additional responses in cases where there were an insufficient number of responses. Questions concerning omissions or anomalies were also answered through additional phone calls.

Extrapolations of waste generation rates were made by assuming that the generation within a particular SIC code was proportional to the total number of employees in that code.

D2.2 Hazardous

A survey made by Alameda County was supplemented for the purposes of this study to include additional firms suspected of generating hazardous wastes. The survey form, cover letter, and mailing list are included in Attachment II. Follow-up phone calls were made to those firms not initially responding. Radioactive wastes were beyond the scope of this study.

Hazardous waste data is tabulated also by SIC codes.

D3 RESULTS

The results of the survey are presented in Tables D-1 through D-4

D3.1 Non-Hazardous

In the Phase One Study, it was estimated that 18,000 tons of non-hazardous industrial refuse per year were generated in Berkeley and disposed of at landfills outside of Berkeley. The survey indicates that a considerably larger quantity is generated; 44,900 tons annually, of which, 18,600 tons per year are estimated to be unsuitable for handling through the Transfer/Processing Station. Materials judged unsuitable include sludges and large volumes of inert materials, such as slag and dust from metal casting mills. These materials would continue to be transported directly to landfills for disposal and not go through a transfer station. This leaves 25,600 tons per year suitable for handling at a Transfer/Processing Station. The survey and conversations with respondents indicate that probably over 50 percent of this remaining material is paper and paper products. Therefore, any fiber recovery, composting or energy conversion which might take place after this material was processed would be augmented by this industrial waste stream. A relatively small portion, 400 tons per year, or two (2) percent, is composed of bulky items which are over six feet in any dimension.

TABLE D-1

INDUSTRIAL/HAZARDOUS WASTES GENERATED IN BERKELEY

	Annual Tons
• Disposed at Berkeley Landfill	
- Material suitable for processing at SWMC*a	1,100
- Material not suitable for processing at SWMC*b	16,800
Total disposed at Berkeley Landfill	18,700
• Disposed at Richmond and Other Class II or Class II-1 Bay Area Landfills	
- Material suitable for processing at SWMC	24,400
- Material not suitable for processing at SWMC	1,800
Total disposed at Richmond and other Landfills	26,200
• Disposed at Class I (Hazardous waste) Sites	41,300
• Currently Recycled (Hazardous and Nonhazardous waste)*c	1,000
• Potentially Recyclables	3,500

*a Primarily paper and wood products.

*b Non-suitable wastes include gypsum mud, casting sand, metal slag, and other such materials.

*c This quantity is not included in total generated.

TABLE D-2

WASTE GENERATION BY INDUSTRIES AND RECYCLABLE MATERIALS

Class	SIC Codes	Number of Firms*a	Number of Employees*a	% of Employees in Firms Responding	Nonhazardous Waste Generated (Tons/Yr.)	Now Recycled (Tons/Yr.)	Additional Nonhazardous Recyclable Material (Tons/Yr.
Food	2000	8	99	76	4400	0	neg.
Lumber & Furniture	2400 2500	26	107	34	800	neg.	800
Printing & Publishing	2700	51	195	38	6400	neg.	100
Chemical & Petroleum	2800 2900	28	2181	60	11,900	300	1400
Rubber, Plastics & Leather	3000 3100	5	177	65	2500	0	neg.
Primary Metal	3300	9	698	57	19,100	100*b	neg.
Fabricated Metal & Machinery	3400 3500	41	875	18	700	500	1000
Electrical & Instruments	3600 3800	27	437	36	300	neg.	100
Miscellaneous	2200 2300 3200 3900	34	292	66	100	100	100
TOTAL		229	5373	49	46,200	1,000	3500

*a Printout of Business License Holders from City of Berkeley Finance Department.

*b 17,000 tons per year slag and sand not included although some is currently used for landfill cover.

TABLE D-3

HAZARDOUS INDUSTRIAL WASTES GENERATED IN BERKELEY
(Annual Tons)

Industry Classification (SIC)

Types of Waste	Chemical & Petroleum 2800, 2900	Rubber, Plastics, & Leather 3000, 3100	Primary Metal 3300	Fabricated Metal & Machinery 3400, 3500
Caustic	472[1]			2[5]
Chlorinated Organics	1[1]			
Chromic Compounds	neg.	250[1]		37,802,[5] 810[2]
Inorganic Compounds	1,200[1]			
Other Acidic Compounds	143[1]			neg.
Other Alkaline Compounds	104[1]			
Other Organic Compounds	80[1]			
Other Heavy Metal Compounds			106,[6] 20,[5] 5,[4]	
Paint Sludge	33,[2] 8,[3] 98,[1] 0.4[4]			
Solvents	264,[1] 6[3]			
Sulfuric Acid				5[5]
TOTAL	2,409	250	131	38,619

(1) Disposed at Richmond Landfill.
(2) Disposed at Industrial Tank, Martinez.
(3) Disposed at Romic Chemical, East Palo Alto; solvents contaminated with paint residuals.
(4) Disposed at Berkeley Landfill, illicitly.
(5) Disposed at other sites or not given.
(6) Recycled.

TABLE D-4

RECYCLABLE NONHAZARDOUS INDUSTRIAL WASTE IN BERKELEY
(Tons/Yr.)

	Generated	Currently Recycled	Percentage Recycled	Not Recycled
Metals				
Iron and Steel	590	550	93	40
Copper & Brass	160	60	38	100
Aluminum	5	5	100	0
Other metal	30	30	100	0
Total metal	785	645	82	140
Paper				
Corrugated boxes	1570	140	9	1430
Hi-grade office	140	20	14	120
Low-grade paper	370	4	1	366
Total paper	2080	164	8	1916
Glass				
Containers	120	0	0	120
Sheet	15	0	0	15
Wood				
Pallets & Dunnage	460	2	1	458
Sawdust	510	7	1	503
Other	340	1	neg.	339
Total wood	1310	10	1	1304
Liquids				
Oil & Grease	70	40	57	30
Solvents	40	20	50	20
Total all materials	4420	879	20	3541

One firm that responded to the survey generates 10,500 tons annually or 23 percent of the projected total. This points out the sensitivity of the analysis when one firm can have such an impact on the total wastes generated. Berkeley is relatively small and has a diverse industrial population. Firms leaving or moving to Berkeley can therefore greatly affect the tonnages generated.

Berkeley Public Works Department staff indicated, prior to the survey, that the City collects relatively little industrial refuse. This was born out by the survey results which show only one percent (1%) collected by City crews. Approximately 46 percent of the non-hazardous refuse is collected by Richmond Sanitary or Berkeley Sanitary Service. The remaining 53 percent is collected by small haulers, taken to a disposal site by the generator, or most commonly hauled to a landfill by a trucking firm.

One goal of the survey was to determine the potential for reducing the amount of industrial waste requiring disposal through additional recycling. The survey results project an additional 3,500 tons which are available (see Table D4). This is eight percent (8%) of the total waste generated or 14 percent of the waste suitable for processing at the SWMC. Currently, 900 tons per year are recycled. The 3,500-ton figure as projected from the survey, is probably less than the real potential. Analysis of the surveys and conversations with respondents indicates that a large quantity of paper is contained in the refuse of responding firms who did not give a breakdown of materials generated. How much more recyclable material is present can only be determined by a composition survey, conducted by sorting and weighing representative samples of collected refuse from industrial drop box routes.

Most of the recycling potential is in two areas: paper and wood. Most of the metal, except copper and brass, is currently recycled. The 1,430 tons per year of additional corrugated boxes potentially recyclable from industry is more than the 800 tons (Reference 1) per month additionally available from retailers. If a collection service for corrugated boxes is established for restaurants, taverns, and retailers, consideration should be given to extending it into the industrial area of the City. In the Phase One Study, 100 to 200 tons per year of scrap wood was estimated to be generated from demolition and construction activities in Berkeley. Much more than this, 1,300 tons per year are projected to be generated by industrial firms. Almost none is currently recycled. Most of this is generated by the 26 firms in the lumber and furniture industries in Berkeley. As waste wood is quite bulky and waste collection and disposal charges are based on volume, it is likely that many of these firms would respond to a wood recycling program. Other materials which could be recycled at the SWMC are:

- Glass Containers, 120 tons per year.
- Oil and grease, 30 tons per year.

Two questions on the survey form asked for opinions, not waste generation data. The first was, "What improvements, if any, do you need?" Three firms mentioned paper recycling or better handling of corrugated boxes. Three mentioned better service, improved response or more frequent pickups. Two firms expressed concern that the City might be contemplating moving further into an area where they thought that private enterprise could do a better job. The balance of the responses, over 80 percent, indicated "none," "satisfactory," or made no response.

The other question sought interest in a waste exchange, an organization which brings sellers and those that can use waste materials together. The fact that seven firms, 13 percent of those surveyed, responded with interest indicates local support for the waste exchange concept.

Materials mentioned that possibly could be part of an exchange were: firewood, organic reagents, paper, printers ink and solvents, scrap plate steel, styrene packing, and cardboard boxes.

D3.2 Hazardous

Approximately 41,300 tons of hazardous wastes are generated annually in Berkeley. One firm accounted for 37,800 tons or 92 percent of the total. Wastes classifications used in Table D-3 are those used by the California Department of Health.

No estimate could be made as to the proportion of wastes which were recyclable as this would require detailed composition information. As with nonhazardous wastes, changes in the industrial population in Berkeley and technological changes could result in rapid changes in the composition and quantity of Berkeley's hazardous waste.

The majority of the hazardous waste generated in Berkeley are currently being disposed of at Bay Area Class I landfills. However, five tons were reported disposed of at Berkeley Landfill. The State Department of Health, Hazardous Materials Section has been notified of the violation.

CITY OF BERKELEY

DEPARTMENT OF PUBLIC WORKS
2180 MILVIA STREET, 5TH FLOOR
BERKELEY, CALIFORNIA 94704
(415) 644-6523

File: 3033

May 22, 1978

Garretson, Elmendorf, Zinov, and Reibin, Architects and Engineers, are under contract with the City of Berkeley to conduct a survey of wastes generated by industries within Berkeley. The purpose of the survey is to enable Berkeley to complete planning for a Solid Waste Management Center for handling and disposal of refuse generated within the City and possibly for recovery of valuable materials from the refuse.

The City is interested in learning what materials are now being recycled by industries in Berkeley and what potential there is for further recycling at the source or recovery of materials at the processing facility. Surveys have already been made of the waste generated by commercial, residential and institutional sources, but relatively little is known about industrial waste generation in Berkeley because much of this waste is picked up by private haulers and disposed of outside Berkeley. Information regarding waste generation by the industrial community of Berkeley is vital to complete the picture of waste generation in the City so that Berkeley will have the capacity to handle that waste if neighboring landfill sites should be closed.

One alternative under consideration for utilization of the organic portion of Berkeley's solid waste is to produce energy, possibly in the form of steam which could be piped to local users. In order to explore the feasibility of this alternative, Garretson, Elmendorf, Zinov and Reibin will identify potential users of steam in the industrial section of Berkeley.

Please fill out the enclosed survey form, including the part covering steam usage if your firm uses steam, and return them in the enclosed self addressed envelope to Garretson, Elmendorf, Zinov and Reibin, 124 Spear Street, San Francisco, CA 94105, attention: Diane Clardy, no later than June 19, 1978. Call Terry Harrison at 527-6780 or Michael Baumann, City of Berkeley Public Works Department at 644-6540 if you have any questions.

Thank you for your participation.

Very truly yours,

Roy Oakes

ROY E. OAKES
Director of Public Works

REO:TH:klm
Attachment

BERKELEY INDUSTRIAL WASTE SURVEY, PART ONE

1. Name of Firm ______________________________

2. Mailing Address ______________________________

3. Location of industrial facilities in Berkeley ______________________________

____

4. Name of person responding ______________ Phone Number ________

5. What is total amount of refuse generated? ________ Cubic Yards per month

________ Tons per month

6. How much of the above refuse, if any, is composed of bulky items with any dimension over 6 feet?

________ Cubic Yards per month

________ Tons per month

7. Who transports your refuse to a disposal site? ______________________________

8. What disposal site does it go to? ______________________________

9. What improvements in service, if any, do you need? ______________________________

____

____

10. Several communities have established waste information exchanges in order to match up generators of materials which can be used as raw materials by another firm with those firms. If you might be interested in this type of information exchange, please indicate what materials you use in your operations which might be generated as waste from another industrial operation.

____

____

11. Do you use more than 10,000 pounds of steam per hour? ______ Yes _____ No

If yes, please complete the Steam Usage Survey in addition to the Recoverable Materials Survey on the following pages.

	Amount Generated Cubic Yds./Mo.	Lbs/Mo.	Amount Recycled Lbs/Mo.	Recycled by Whom
ALS				
errous: Steel & Iron				
on-Ferrous: Copper & Brass				
Aluminum				
Lead				
Other (Specify) ____				
R PRODUCTS				
rrugated (Cardboard) Boxes nd Kraft Paper				
fice Paper, High Grade IBM Cards, Computer Print-outs, White Ledger)				
fice Paper, Low Grade				
s				
ntainers				
ner (Specify) ____				
lets and Dunnage				
dust				
er				
D WASTE				
and Grease				
vents (Specify) ____				
er				
WASTES				
cify) ____				

2000*

Canada Dry Corp.
1001 Camelia
Berkeley Ca. 94710

2000

Moti Mahal
2507 Dwight
Berkeley Ca. 94704

2011

Lewis and Mcdermot
1120 2nd St.
Berkeley Ca 94710

2020

Golden Rich Corp.
2031 2nd St.
Berkeley Ca. 94710

2033

Bell-Carter Olive Co.
1045 Folger Ave
Berkeley Ca. 94710

2034

Family Orchards Inc.
2546 10th St.
Berkeley Ca. 94710

2075

Tyson's Soybean
2546 10th St.
Berkeley Ca. 94710

2261

Berkeley T-Shirt
1357 Peralta Ave
Berkeley Ca. 94702

2087

Universal Flavors
1818 Harmon St.
Berkeley Ca. 94710

2291

Wheeler Manufacturing Co.
2115 Milvia
Berkeley Ca. 94704

2300

Love Nancy
2147 Russell
Berkeley Ca. 94705

2331

Ariadne's Treasure Chest
2611 Fulton
Berkeley Ca. 94704

2352

Interstellar Propell
1600 Woolsey
Berkeley Ca. 94704

2391

Bogdanov Zoya
2845 Prince
Berkeley Ca. 94705

2400

Dick Ahlstrand
1281 Hearst St.
94702

2400

Arm and Hammer
2019 Blake St.
Berkeley Ca. 94704

2400

Beck and Lawler Wood
1000 Murray St.
Berkeley Ca 94710

2400

Bench Mark/Spec
2831 Tenth St.
Berkeley Ca. 94710

2400

Berkeley Woodcraft, Inc.
1814 San Pablo Ave
Berkeley Ca. 94710

2400

Contractor's
2821 Ninth St.
Berkeley Ca. 94710

2400

Dean Williamson
1534 Milvia Apt. E
Berkeley Ca. 94709

2400

Mordaunt Woodwork
1311 Acton St.
Berkeley Ca. 94706

2400

William Seward
935 Channing Way
Berkeley Ca. 94710

2400

Curt Siddall
2547 Eighth St.
Berkeley Ca. 94710

2400

Bob Stocksdale
2147 Oregon St.
Berkeley Ca. 94705

2400

Carl D. Westley
1320 Stannage
Berkeley Ca. 94702

2400

Eli Wilson Cabinet
924 Gilman St.
Berkeley Ca. 94710

* Four digit Standard Industrial Classification Code.

2400

Wucher Enterprises
2332 Channing Way
Berkeley Ca. 94704

2431

Robert Sullivan
730 Spruce St.
Berkeley Ca. 94708

2434

Circadian Woodwork
2547 Eighth St.
Berkeley Ca. 94710

2434

Escoto Bros
1150 Sixth St.
Berkeley Ca. 94710

2434

Heathwood Cabin
2547 Eighth St. Apt. K
Berkeley Ca. 94710

2499

Don Duncan
2454 Telegraph Ave
Berkeley Ca. 94704

2499

Perrish Photograph
2332 Fourth St.
Berkeley Ca. 94702

2500

C. F. Cooper Woodwork
1250 Addison St.
Berkeley Ca. 94702

2500

The Sun
731 Virginia
Berkeley Ca. 94710

2500

Timberline Furniture
2015 Blake St.
Berkeley Ca. 94704

2515

Beds, Beds, and Sofa Beds
2001 University
Berkeley Ca. 94704

2700

Acc. Printers
1919 Fifth St.
Berkeley Ca. 94710

2700

Al-iman
2216 San Pablo
Berkeley Ca. 94710

2700

And/Or Press
1409 Fifth St.
Berkeley Ca. 94710

2700

Apollo Printing
1849 University Ave
Berkeley Ca. 94703

2700

Baccus Press
1715 University Ave
Berkeley Ca. 94703

2700

Berkeley Scientific
1603 Solano Ave
Berkeley Ca. 94706

2700

Berkeley Engraving
2121 Allston Way
Berkeley Ca. 94704

2700

Brandes Printing Co.
726 Addison St.
Berkeley Ca. 94710

2700

Consolidated Press
2630 Eighth St.
Berkeley Ca. 94710

2700

Consumer Data System
1525 Shattuck
Berkeley Ca. 94709

2700

Edit'l Justa Pu
2831 Seventh St.
Berkeley Ca. 94710

2700

Explorations Inc.
1711 A Grove
Berkeley Ca. 94709

2700

Gazette Press Inc.
846 Anthony
Berkeley Ca. 94710

2700

Gillick Printing
1700 Fifth St.
Berkeley Ca. 94710

2700

H&C Custom Publishing
2855 Telegraph/2nd Floor
Berkeley Ca. 94705

2700

Hooper and Schmidt
3109 A Shattuck
Berkeley Ca. 94705

2700

Information Unlimited
2510 Channing 3
Berkeley Ca. 94704

2700

Ed Kirwan and Graph
2440 Bancroft Way
Berkeley Ca. 94704

2700

Landscapre Magazine
3000 College Ave
Berkeley Ca. 94705

2700

Lederer Street
2121 Allston
Berkeley Ca. 94704

2700

Mercurio Bros. Printing
2830 San Pablo
Berkeley Ca. 94710

2700

Montague and Sprage
742 Virginia St.
Berkeley Ca. 94710

2700

Pacific Rota Printing
2832 San Pablo
Berkeley Ca. 94710

2700

People's World
1819 Tenth St.
Berkeley Ca. 94710

2700

Professional Press
2434 Dwight Way
Berkeley Ca. 94704

2700

Rein Floyd Printing
988 University Ave
Berkeley Ca. 94710

2700

Thelma Robison
2489 Telegraph
Berkeley Ca. 94704

2700

Saint Heironymo
1703 Grove St.
Berkeley Ca. 94709

2700

Smith Printing
1605 Solano Ave
Berkeley Ca. 94706

2700

West Coast Printing
3051 Adeline St.
Berkeley Ca. 94703

2700

Western Roto En
1225 Sixth St.
Berkeley Ca. 94710

2711

Berk/Barb Third
2042 University Ave
Berkeley Ca. 94704

2711

Berkeley Gazette
2043 Allston Way
Berkeley Ca. 94704

2711

Berkeley Monthly
2275 Shattuck
Berkeley Ca. 94704

2711

The Daily Californian
2490 Channing
Berkeley Ca. 94704

2711

East Bay Review
650 Camelia
Berkeley Ca. 94710

2711

Lewis Publishing
2490 Channing Way/2nd Flr.
Berkeley Ca. 94704

2731

Howell-North Bo
1050 Parker St.
Berkeley Ca. 94710

2731

Ten Speed Press
900 Modoc
Berkeley Ca. 94707

2732

Berkeley Graphics
2375 Telegraph
Berkeley Ca. 94704

2751

Berkeley Blue Print
1798 University Ave
Berkeley Ca. 94703

2752

E&C Offset
1275 San Pablo
Berkeley Ca. 94704

2752

Litho Process Co.
2829 Seventh St.
Berkeley Ca. 94710

2789

Economy Bindery
1023 Heinz Ave
Berkeley Ca. 94710

2791

Breakas Typesetting
1700 Fifth Ave.
Berkeley Ca. 94710

2799

Archetype
2512 Grove St.
Berkeley Ca. 94703

2800

Airco Temescal
2850 Seventh St.
Berkeley Ca. 94710

2800

Barr Chemical P
2748 Ninth
Berkeley Ca. 94710

2800

Colgate Palmolive
2700 Seventh St.
Berkeley Ca. 94710

2800

Janco Chemical Corp.
1235 Fifth St.
Berkeley Ca. 94710

2800

Metro Overland
675 Cedar St.
Berkeley Ca. 94710

2800

Micro-Chemical S
1825 Eastshore Highway
Berkeley Ca. 94710

2800

National Starch
742 Grayson
Berkeley Ca. 94710

2800

Newcell Bio Chem
1508 Fifth St.
Berkeley Ca. 94710

2813

Ohio Medial Pr
1231 Second
Berkeley Ca. 94710

2820

Plastic Works
2547 Eighth
Berkeley Ca. 94710

2831

Berkeley Biolog
1831 Second St.
Berkeley Ca. 94710

2831

Bio-Medics
2521 Telegraph Ave.
Berkeley Ca. 94704

2831

Cetus Corporation
600 Bancroft Way
Berkeley Ca. 94710

2831

Cutter Laboratories
Fourth and Parker Streets
Berkeley Ca. 94710

2834

Stayner Corp.
2531 Ninth St.
Berkeley Ca. 94710

2851

De Soto Inc.
1600 Fourth St.
Berkeley Ca. 94710

2851

Green Chemical
801 Gilman
Berkeley Ca. 94710

2851

Lomax Paint Co. Inc.
2222 Third St.
Berkeley Ca. 94710

2851

Precision Technical
1220 Fourth
Berkeley Ca. 94710

2851

Standard Paint
700 Allston Way
Berkeley Ca. 94710

2899

O.L. King Co. Div Far-Best
640 Gilman
Berkeley Ca. 94710

2851

Thomson A H Co.
695 Cedar St.
Berkeley Ca. 94710

2851

Triangle Paint
2222 Third St.
Berkeley Ca. 94710

2891

Poly-Seal Inc.
725 Channing Way
Berkeley Ca. 94710

2893

Cal & Ink Div/Fli
711 Camelia St.
Berkeley Ca. 94710

2893

Converters Ink
635 Cedar St.
Berkeley Ca. 94710

2899

Bao Jin Hsueh
1409 Fifth St.
Berkeley Ca. 94710

2911

Berkeley Asphalt Co.
699 Virginia St.
Berkeley Ca. 94710

2952

Imperial Coating
1001 Ashby Ave
Berkeley Ca. 94710

3041

Dura Belting Co.
715 Heinz
Berkeley Ca. 94710

3079

Emerald Packaging
2821 Tenth St.
Berkeley Ca. 94710

3079

Gibbs Plastics
725 Channing Way
Berkeley Ca. 94710

3079

Kennerley & Sprat
1456 Fourth St.
Berkeley Ca. 94710

3111

Manasse Block Tanning
1300 Fourth St.
Berkeley Ca. 94710

3229

Creative Glass
1825 Eastshore Highway
Berkeley Ca. 94710

3229

Tinsley Laboratories
1448 Sixth St.
Berkeley Ca. 94710

3231

Lab Systems
1330 Grove St.
Berkeley Ca. 94709

3231

Laboratory Glass App
1200 Fourth
Berkeley Ca. 94710

3253

T.W.P. Co. Inc.
2019 Blake St.
Berkeley Ca. 94704

3269

Cohen H/Levy E
1805 Second
Berkeley Ca. 94710

3300

A & B Die Casting
1417 Fourth
Berkeley Ca. 94710

3300

Berkeley Forge &
1330 Second
Berkeley Ca. 94710

3300

East Bay Steel
900 Murray St.
Berkeley Ca. 94710

3300

Feeney Wire Rop
600 Addison
Berkeley Ca. 94710

3300

Macaulay H C F
811 Carleton
Berkeley Ca. 94710

3300

Pac Pressure Ca
1210 Fourth
Berkeley Ca. 94710

3325

Pacific Steel Co.
1333 Second
Berkeley Ca. 94710

3360

S.K.S. Die Casting
2200 Fourth
Berkeley Ca. 94710

3362

Berkeley Brass
2629 Seventh St.
Berkeley Ca. 94710

3400

Berkeley Craftsman
2905 Shattuck
Berkeley Ca. 94705

3400

Merit Tank and
707 Gilman
Berkeley Ca. 94710

3400

Hawkins and Hawkins
1255 Eastshore Highway
Berkeley Ca. 94710

3400

Model Airplane Motors
2332 Fifth St.
Berkeley Ca. 94710

3400

Oliver Screw Product
1821 Fifth St.
Berkeley Ca. 94710

3400

Utility Body Co.
901 Gilman St.
Berkeley Ca. 94710

3423

Ro & Lett Tools Die MF
1823 Fifth St.
Berkeley Ca. 94710

3429

Podl & Lok Company
901 Gilman St.
Berkeley Ca. 94710

3431

Haw's Drinking Faucet
2435 Fourth St.
Berkeley Ca. 94710

3442

V & W Patio Floor
2815 Seventh St.
Berkeley Ca. 94710

3446

Up & Right Scaffold
1013 Pardee St.
Berkeley Ca. 94710

3471

Electro-Coating
893 Carleton St.
Berkeley Ca. 94710

3471

Stainless Polis
240 Potter St.
Berkeley Ca. 94710

3479

Tienson Engraving Co.
2816 Eighth St.
Berkeley Ca. 94710

3499

Allenite Products
801 Addison St.
Berkeley Ca. 94710

3499

Independence Industries
2824 Eighth St.
Berkeley Ca. 94710

3500

Clearflow Valves
631 Camelia St.
Berkeley Ca. 94710

3500

Commercial Air Conditioning
702 Harrison
Berkeley, Ca. 94710

3500

Finishing Process Co.
1861 Fifth St.
Berkeley Ca. 94710

3500

Metal Finishing
800 Bancroft Way
Berkeley Ca. 94710

3500

Scott & Company
2345 Fourth St.
Berkeley Ca. 94710

3547

Proto-Pipe
2398 Fourth St.
Berkeley Ca. 94710

3561

Berkeley Pump Co.
829 Bancroft Way
Berkeley Ca. 94710

3565

A & L Pattern
845 Carleton St.
Berkeley Ca. 94710

3565

Berkeley Patterning & MFG
2612 Ninth
Berkeley Ca. 94710

3565

Edco Pattern
2612 Ninth St.
Berkeley Ca. 94710

3565

J & R Pattern Co.
633 Camelia St.
Berkeley Ca. 94710

3576

Parson's Automat
1331 Eighth St.
Berkeley Ca. 94710

3599

Benda Tool & Model Work
1417 Fourth St.
Berkeley Ca. 94710

3499

Elco
1348 Seventh St.
Berkeley Ca. 94710

3599

Elco Manufacturing
742 Delaware St.
Berkeley Ca. 94710

3599

Grant Instruments Inc.
1805 Eastshore Highway
Berkeley Ca. 94710

3599

Howlett Machine Work
746 Folger Ave.
Berkeley Ca. 94710

3599

Kowal Manufacturing Co.
2414 Sixth St.
Berkeley Ca. 94710

3599

McElroy Stinger
648 Page St.
Berkeley Ca. 94710

3599

Monarch Manufacturing Co.
1218 Santa Fe Ave.
Berkeley Ca. 94706

3599

Oldershaw
2011 Blake St.
Berkeley Ca. 94704

3599

Pedco
1618 Sixth St.
Berkeley Ca. 94710

3599

Production Job Shop
825 Gilman St.
Berkeley Ca. 94710

3599

Tito's Machine Shop
2321 San Pablo Ave.
Berkeley Ca. 94702

3599

Watamura, Abe
2610 Ninth St.
Berkeley Ca. 94710

3600

Argo Sign Co. Inc.
1036 Ashby Ave.
Berkeley Ca. 94710

3600

A.R.S. Associates
3351 Grove St.
Berkeley Ca. 94703

3600

Autogenic Systems
809 Allston Way
Berkeley Ca. 94710

3600

Berkeley Nucleo
1198 Tenth St.
Berkeley Ca. 94710

3600

Calcon
2212 Sixth St.
Berkeley Ca. 94710

3600

Graysix Co.
2427 Fourth St.
Berkeley Ca. 94710

3600

Ignition Systems
2547 Eighth St.
Berkeley Ca. 94710

3600

PCC/Caltron Industries
2015 Second St.
Berkeley Ca. 94710

3612

California Street
723 Dwight Way
Berkeley Ca. 94710

3623

ADVANCE HELI WELDERS
938 Pardee St.
Berkeley Ca. 94710

3640

Inlite Corporation
939 Grayson St.
Berkeley Ca. 94710

3640

Peerless Electric
747 Bancroft Way
Berkeley Ca. 94710

3662

Cyclotron Corp
950 Gilman Street
Berkeley Ca. 94710

3679

Rheodyne Inc.
2809 Tenth St.
Berkeley Ca. 94710

3714

T.A.C. Enterprises
1348 Seventh St.
Berkeley Ca. 94710

3732

Walsh Bros Machine Work
1205 Tenth St.
Berkeley Ca. 94710

3800

Altex Scientific
1780 Fourth St.
Berkeley Ca. 94710

3800

Bio-Engr. Research
806 Camelia St.
Berkeley Ca. 94710

3800

Evans Associates
134 The Uplands
Berkeley Ca. 94709

3800

Food Systems Inc.
950 Grayson St.
Berkeley Ca. 94710

3800

Kenlab Incorporated
1060 Harrison St.
Berkeley Ca. 94710

3800

Orion Research
1832 Second St.
Berkeley Ca. 94710

3800

Praxis Electronics
650 Camelia St.
Berkeley Ca. 94710

3800

Research Development
1808 Harmon St.
Berkeley Ca. 94703

3800

Schema Versatae
2203 Fourth St.
Berkeley Ca. 94710

3811

Andros Incorporated
2332 Fourth St.
Berkeley Ca. 94710

3811

Lab Industries Inc.
1802 Second St.
Berkeley Ca. 94710

3823

George Associates
2734 Tenth St.
Berkeley Ca. 94710

3851

Permanente Medical G.
1750 Second St.
Berkeley Ca. 94710

3861

Chemco Photo Products
1223 Eighth St.
Berkeley Ca. 94710

3953

Albany Rubber Stamp
1607 Solano Ave.
Berkeley Ca. 94706

3953

Atlas Enterprises
1611 San Pablo Ave.
Berkeley Ca. 94703

3953

H.R. Ellis Co.
1680 University Ave.
Berkeley Ca. 94703

3970

Anderson Laboratories
805 Camelia
Berkeley Ca. 94710

3970

Berglin Manufacturing
2331 Fifth St.
Berkeley Ca. 94710

3970

Berkeley Art Form
1231 Fourth St.
Berkeley Ca. 94710

3970

Custom Equipts. & D.E.S.
715 Dwight Way
Berkeley Ca. 94710

3970

Fatty's Candles
907 Camelia St.
Berkeley Ca. 94710

3970

Front Yard
1270 San Pablo Ave.
Berkeley Ca. 94710

3970

H.B. Manufacturing
1041 Grayson St.
Berkeley Ca. 94710

3970

Oscar Krenz Incoporated
750 Potter St.
Berkeley Ca. 94710

3970

Oscar Enterprises
1716 Fourth St.
Berkeley Ca. 94710

3970

Philadelphia Quartz
801 Grayson St.
Berkeley Ca. 94710

3970

Proen Products
2777 Ninth St.
Berkeley Ca. 94710

3970

Rucraft Incorporated
707 Jones St.
Berkeley Ca. 94710

3970

Trailwise Incorporated
2407 Fourth St.
Berkeley Ca. 94710

3970

Tuttle Manufacturing
Fourth & Gilman Streets
Berkeley Ca. 94710

3999

Coker Enterprises
2612 Ninth St.
Berkeley Ca. 94710

3999

Jaffe Candle Works
907 Camelia St.
Berkeley Ca. 94710

3999

Magic Candles
709 Jones Rear
Berkeley Ca. 94710

GARRETSON • ELMENDORF • ZINOV • REIBIN
ARCHITECTS AND ENGINEERS

124 SPEAR STREET   SAN FRANCISCO, CALIFORNIA 94105   TELEPHONE 415-434-3838

Reference: 1562
Contract: --
Project: Energy Recovery Feasibility Study Berkeley, California
Subject: Hazardous Waste Survey

Gentlemen:

The City of Berkeley contracted with our firm to survey Berkeley industries about the types and quantities of hazardous wastes that are currently being produced in the City. The responses to the survey will provide the City with information necessary to develop a comprehensive waste management plan for the future.

The survey form enclosed contains questions about your process and about the type and quantity of waste you are currently producing. Providing exact answers to a number of these questions may be difficult and your best guess or estimation will be adequate. We would appreciate your returning the completed survey form within ten (10) days of receipt. A stamped return-addressed envelope is enclosed for your convenience. If you have any questions regarding the survey, please contact Thomas Reilly of our firm at 434-3838, or Michael J. Baumann with the City of Berkeley Public Works Department at 644-6540.

We regret having to ask you to take time to complete this form. However, the information will benefit the City and make long-range planning possible. Your attention to this matter is greatly appreciated.

Very truly yours,

GARRETSON•ELMENDORF•ZINOV•REIBIN
ARCHITECTS AND ENGINEERS

Michael D. Brown
Chief Environmental Engineer

Originated by: D. Clardy
DC:ar

cc: Mr. Michael J. Baumann

Attachment

B. GARRETSON, P.E., A.I.A., PRESIDENT — J. H. ELMENDORF, P.E., VICE PRESIDENT & GENERAL MANAGER — P. L. ZINOV, A.I.A., ARCHITECT — F. M. REIBIN, P.E., ELECTRICAL ENGINEER — J. D. LEACH, P.E., CIVIL & STRUCTURAL ENGINEER — R. H. AHEARN, P.E., MECHANICAL ENGINEER

4. Please complete the hazardous wastes table of information (centerfold) for your operations.

5. Please indicate the names of haulers and off-site disposal facilities utilized for:

Liquids ______________________________
(Hauler) (Disposal Site)

Solids ______________________________
(Hauler) (Disposal Site)

6. RESOURCES RECOVERED

What hazardous materials are recovered from your operation's wastes?

(Material recovered)	(Annual amount)	By whom? (ck. below) (Company)	(Others)
		☐	☐
		☐	☐
		☐	☐

7. COMMENT

____
____
____
____
____
____
____
____

HAZARDOUS WASTE SURVEY

A. GENERAL INFORMATION

1. Company ______________________________
2. Branch ______________________________
3. ______________________________
(Street & No.) (City) (County) (Zip) (Phone)
4. Person Completing Survey Form ______________________________
(Name) (Title) (Phone)
5. What is your principal product or service? ____________
6. Primary SIC code: ______________________________

B. INDUSTRIAL WASTES

1. Does your waste or waste mixture have any of the following properties?

Carcinogenic	☐	Flammable	☐
Corrosive	☐	Irritant/strong sensitizer ...	☐
Explosive	☐	Toxic	☐
Nontoxic	☐	Do not know	☐

2. Does your operation's waste generation change seasonally? Yes ☐ No ☐

If yes, when does peak occur? ______________________________
(Please specify time period)

3. How are your operation's wastes stored prior to disposal/transportation?

Barrels (not steel)...	☐	Special packaging	☐
Concrete encased	☐	Steel drums	☐
Open yard	☐	Tanks	☐
Plastic encased	☐	Warehouse	☐
Ponds	☐	Other ____________ (Please specify)	
Pressure containers ..	☐	None stored	☐

(Turn to back page)

HAZARDOUS WASTES

TABLE OF INFORMATION

PROCESS		ASSOCIATED WASTE		PHYSICAL STATE Specify(i.e., liquid,Solid, gaseous)	If Liquid ESTIMATED CONCENTRATION (% or ppm)	ESTIMATED ANNUAL VOLUME: PRESENT (Best Guess)	POUNDS, BARRELS TONS OR GALLONS (INDICATE WHICH)	please use key sheet: DISPOSAL POINT (1-3)	PROCESS EMPLOYED: TREATMENT PROCESS	DISPOSAL MODE	SHIPPING CONTAINER
A.		1.									

LIST OF FIRMS SURVEYED FOR HAZARDOUS WASTES

Surveyed by Alameda County

A & B Die Casting Company
1417 4th St., Berkeley, CA 94710
Phone: 525-0717
SIC: 3300

Advance Research, Incorporated
1326 9th St., Berkeley, CA 94710
Phone: 527-5255
SIC: 2842

Alcan Metal Powders, Incorporated
Division of Alcan Aluminum Corporation
1069 2nd St., Berkeley, CA 94710
Phone: 526-3722
SIC: 3399 3295 2851

American Supply Company
1108 Blake St., Berkeley, CA 94702
Phone: 843-0275
SIC: 5095

Bao Jin Hsueh
1409 5th St., Berkeley, CA 94710
Phone: 527-4558
SIC: 2899

Barr Chemical Products, Incoporated
2748 9th St., Berkeley, CA 94710
Phone: 848-1954
SIC: 2800

Berkeley Art Foundry
1231 4th St., Berkeley, CA 94710
Phone: 525-3617
SIC: 3970

Berkeley Asphalt Company
699 Virginia St., Berkeley, CA 94710
Phone: 526-1611
SIC: 2911

Berkeley Biologicals
2nd & Hearst Sts., Berkeley, CA 94710
Phone: 843-6846
SIC: 2831

Berkeley Brass Foundry
2629 7th St., Berkeley, CA 94710
Phone: 845-6952
SIC: 3362

Berkeley Custom Electronics, Inc.
2302 Roosevelt Ave., Berkeley, CA 94703
Phone: 843-4180
SIC: 3674

Berkeley Forge and Tool
1330 2nd St., Berkeley, CA 94710
Phone: 526-5034
SIC: 3300

Berkeley Readymix
699 Virginia St., Berkeley, CA 94710
Phone: 526-9022
SIC: 5030

Chromex
2743 8th St., Berkeley, CA 94710
Phone: 849-1916
SIC: 3471

Colgate-Palmolive Company
2700 7th St., Berkeley, CA 94710
Phone: 845-1500
SIC: 2800

Converters Ink Company
635 Cedar St., Berkeley, CA 94710
Phone: 524-2772
SIC: 2893

The Cosmetic Chemist
1221 8th St., Berkeley, CA 94710
Phone: 525-5842
SIC: 5122

Cutter Laboratories
4th & Parker Sts., Berkeley, CA 94710
Phone: 841-0123
SIC: 2831

Cyclotron Corporation
950 Gilman St., Berkeley, CA 94710
Phone: 524-8670
SIC: 3662

De Soto Incorporated
1608 4th St., Berkeley, CA 94710
Phone: 526-1525
SIC: 2851

D. M. Silver Plating Company
1954 University Ave., Berkeley, CA 94704
Phone: 848-0405
SIC: 3471

Dura Belting Company
715 Heinz Ave., Berkeley, CA 94710
Phone: 841-2612
SIC: 3041

Elco Manufacturing Company
742 Delaware St., Berkeley, CA 94710
Phone: 848-5955
SIC: 3599

Electro-Coatings, Incorporated
893 Carleton St., Berkeley, CA 94710
Phone: 849-4075
SIC: 3471

Far-Best Corporation, O. L. King Div.
640 Gilman St., Berkeley, CA 94710
Phone: 525-2534
SIC: 2992

Finishing Process Company
1821 5th St., Berkeley, CA 94710
Phone: 841-2756
SIC: 3500

Green Chemical Products
801 Gilman St., Berkeley, CA 94710
Phone: 525-7730
SIC: 2851

Industrial Engravers
800 Addison St., Berkeley, CA 94710
Phone Nos.: 843-7856 & 843-7648
SIC: 3953

Industrial Silver Company
1717 4th St., Berkeley, CA 94710
Phone: 527-7100
SIC: 3339

Johnson Gear & Manufacturing Co., Ltd.
921 Parker St., Berkeley, CA 94710
Phone: 845-7376
SIC: 3398 3462

Leber Ink Company
2832 10th St., Berkeley, CA 94710
Phone: 849-3183
SIC: 5085

Lomax Paint Company
2222 3rd St., Berkeley, CA 94710
Phone: 548-1520
SIC: 2851

Manassee-Block Tanning Company
1300 4th St., Berkeley, CA 94710
Phone: 525-8648
SIC: 3111

Metal Finishing, Div. of Veriflow Corporation
800 Bancroft Way, Berkeley, CA 94710
Phone: 841-0151
SIC: 3500

Metro-Overland Manufacturing Company
675 Cedar St., Berkeley, CA 94710
Phone: 526-4177
SIC: 2800

Monsen Plating & Silversmiths
3370 Adeline St., Berkeley, CA 94703
Phone: 655-0890
SIC: 7680

National Starch & Chemical
742 Grayson St., Berkeley, CA 94710
Phone: 841-4530
SIC: 2800

Ohio Medical Products, Division of Airco Incorporated
1231 2nd St., Berkeley, CA 94710
Phone: 526-3365
SIC: 2813

Pacific Pressure-Cast Products
1210 4th St., Berkeley, CA 94710
Phone: 525-0366
SIC: 3300

Philadelphia Quartz Company of California
801 Grayson St., Berkeley, CA 94710
Phone: 845-1048
SIC: 3970

P. K. Machine Company
5861 Christie Ave., Berkeley, CA 94710
Phone: 658-1132
SIC: 2821

Proen Products Company
2777 9th & Grayson Sts., Berkeley, CA 94710
Phone: 848-5504
SIC: 3970

Reliance Sheet & Strip Company
722 Folger Ave., Berkeley, CA 94710
Phone: 843-3123
SIC: 4289

Rucraft Incorporated
707 Jones St., Berkeley, CA 94710
Phone: 526-2550
SIC: 3970

Ryder Chemical Company
701 Heinz Ave., Berkeley, CA 94710
Phone: 843-3473
SIC:

Scott, R. W. & Rubber Company
2345 4th St., Berkeley, CA 94710
Phone: 843-3835
SIC: 3500

SKS Die Casting, Div. of Whittaker Corp.
2200 4th St., Berkeley, CA 94710
Phone: 843-1844
SIC: 3360

Snow Lion Corporation
1330 9th St., Berkeley, CA 94710
Phone: 525-4010
SIC: 2294

Stainless Polishing Corporation
840 Potter St., Berkeley, CA 94710
Phone: 548-7620
SIC: 3471

Stayner Corporation
2531 9th St., Berkeley, CA 94710
Phone: 843-9100
SIC: 2834

Tenneco Chemicals, Incorporated,
California Ink Divivion
711 Camelia St., Berkeley, CA 94710
Phone: 525-1188
SIC: 2893

Thompson, A. H. Company
300 Cedar St., Berkeley, CA 94710
Phone: 526-8686
SIC: 2851

Triangle Paint Company
2222 - 3rd St., Berkeley, CA 94710
Phone: 845-6931
SIC: 2851

Tri-City Paint Company
1220 4th St., Berkeley, CA 94710
Phone: 525-3600
SIC: 2851

Tuttle Manufacturing Company
725 Gilman St., Berkeley, CA 94710
Phone: 525-1311
SIC: 3970

Unicorn Chemical Coatings, Incorporated
dba Standard Paint Company
700 Allston Way, Berkeley, CA 94710
Phone: 848-2863 SIC:

Veriflow Corporation
800 Bancoft Way, Berkeley, CA 94710
Phone: 841-0151
SIC: 3471

Universal Anchors Company
950 Parker Ave., Berkeley, CA 94710
Phone: 548-2636
SIC: 5030

Utility Body Company
901 Gilman St., Berkeley, CA 94710
Phone: 524-9333
SIC: 3400

West Company
1840 4th St., Berkeley, CA 94710
Phone: 548-1570
SIC: 2842

Willis-Moore Paint Specialties
1840 4th St., Berkeley, CA 94710
Phone: 549-0934
SIC: 2851

LIST OF FIRMS SURVEYED FOR HAZARDOUS WASTES

Surveyed by: Garretson•Elmendorf•Zinov•Reibin,
Architects and Engineers

Bio-Medics
2521 Telegraph Avenue
Berkeley, California 94704

Cetus Corporation
600 Bancroft Way
Berkeley, California 94710

Gibbs Plastics
725 Channing Way
Berkeley, California 94710

H.C. MacAulay Foundry Company
811 Carleton Street
Berkeley, California 94710

Imperial Coating
1001 Ashby Avenue
Berkeley, California 94710

Pacific Steel
1333 Second Street
Berkeley, California 94710

Plastic Works
2547 Eighth Street, Apt. B
Berkeley, California 94710

Precision Technical
1220 Fourth Street
Berkeley, California 94710

Standard Paint
700 Allston Way
Berkeley, California 94710

APPENDIX E

TRANSPORTATION COST ANALYSIS

APPENDIX E

TRANSPORTATION COST ANALYSIS - DIRECT HAUL VS. TRANSFER AND HAUL

A. DIRECT HAUL

1. System Information

• Existing City Vehicles	18
• Tons Currently Collected by City Vehicles	150 tons/day*a
• Design Capacity (1.2)*b (150 tons/day)	180 tons/day
• Cost Per Collection Vehicle*c (20 cubic yard; 6 maximum ton payload)	$50,000/vehicle*d
• Amortization Per Vehicle (10 years, 6%)	$ 6,800/year
• Spare Vehicles	
- if vehicles number less than 10	1
- if vehicles number less than 20, more than 10	2
- if vehicles number less than 30, more than 20	3
• Average Time Spent Disposing of Refuse	.2 hours/trip
• Vehicle Labor Cost (two-man crews)*e	$44,900/year
• Average Working Hours	8 hours/day
• Average Refuse Pickup Rate	0.90 tons/hour*f
• Operation and Maintenance Costs	$1.25/mile*g
• Number of Trips Per Vehicle To Disposal Site	1 trip/day

---

*a Five days per week, Reference 1.

*b Seasonal load factor.

*c Because existing vehicles are not designed for a longer haul operation, it is assumed that the fleet would need total replacement. Replacement vehicles are assumed to use two-man crews, and be capable of traveling at posted speed limits on highways.

*d Cost includes 10 percent contingencies.

*e Both crew members are paid driver salary @ $22,450 per year.

*f Rate currently experienced by City, three-man crews reduce by 25 percent due to reduction to two-man crews.

*g Cost estimates obtained from County of Sacramento (data that was not only accessible to Contractor, but representative of what could be expected in Berkeley if direct haul to a distant landfill occurred).

2. Individual Route Costs (Sample calculations are provided for West Contra Costa County).

a. West Contra Costa County (Richmond)

• Route Information

Round-Trip Miles	24*a
Average Driving Time for Haul Per Trip (hours)	0.73
Hours Remaining For Collection Per Day (8 hrs./day - 0.73 hrs./haul/day - .2 hrs./disposal/day)	7.03
Tons Collected Per Crew Per Day (0.90 tons/hr./crew) (7.03 hrs./day) or 6 tons/vehicle*b whichever is less	6.33
Vehicles (Crews) Required (180 tons/day)/(6 tons/day/vehicle)	30
Spare Vehicles (Required vehicles number less than 20)	3
Total Annual Miles (30 Vehicles) (24 miles/trip) (260 days/year)	187,200

• Annual Route Costs

Amortization of Vehicles (30 vehicles)*c ($6,800/vehicle)	$204,000
Additional Vehicle Labor Requirements (30 crews required/day) (2 men/crew) - (18 City Crews)(3 men/crew)	$134,700
Operation and Maintenance Over Haul Distance (137,280 miles/year) ($1,25/mile)	$234,000
Total Annual Cost	$572,700
Cost Per Ton ($591,500/year)/(150 tons/day) (260 days/year)	$14.70

*a From Second and Gilman Streets, Berkeley, to disposal site and return.

*b Maximum payload. In those cases where more tons could be collected per crew in the time provided, 6 tons will control.

*c The City currently purchases three vehicles every year. The marginal cost of direct hauling therefore requires the amortization of the vehicles required for direct haul plus spares minus the three purchases every year.

b. Northern Alameda County

- Route Information

Round-Trip Miles	20
Average Driving Time Per Trip (hours)	0.70
Hours Remaining for Collection	7.30
Tons Collected Per Crew Per Day	6.57
Vehicles (Crews) Required	28
Spare Vehicles	3
Total Annual Miles	145,600

- Annual Route Costs

Amortization of Vehicles	$190,400
Additional Vehicle Labor Requirements	$ 44,900
Operation and Maintenance Over Haul Distance	$182,000
Total Annual Cost	$336,300
Cost Per Ton	$8.60

c. Davis Street

- Route Information

Round-Trip Miles	30
Average Driving Time Per Trip (hours)	.83
Hours Remaining for Collection	7.17
Tons Collected Per Crew Per Day	6.45
Vehicles (Crews) Required	30
Spare Vehicles	3
Total Annual Miles	234,000

• Annual Route Costs

Amortization of Vehicles	$204,000
Additional Vehicle Labor Requirements	$134,700
Operation and Maintenance Over Haul Distance	$292,500
Total Annual Cost	$631,200
Cost Per Ton	$16.20

d. <u>Acme Fill</u>

• Route Information

Round-Trip Miles	52
Average Driving Time Per Trip (hours)	1.30
Hours Remaining for Collection	6.70
Tons Collected Per Crew Per Day	6.03
Vehicles (Crews) Required	30
Spare Vehicles	3
Total Annual Miles	405,600

• Annual Route Costs

Amortization of Vehicles	$204,000
Additional Vehicle Labor Requirements	$134,700
Operation and Maintenance Over Haul Distance	$507,000
Total Annual Cost	$845,700
Cost Per Ton	$26.70

e. U. S. Steel (Pittsburgh)

- Route Information

Round-Trip Miles	78
Average Driving Time Per Trip (hours)	1.6
Hours Remaining for Collection	6.40
Tons Collected Per Crew Per Day	5.76
Vehicles (Crews) Required	32
Spare Vehicles	3
Total Annual Miles	648,960

- Annual Route Costs

Amortization of Vehicles	$217,600
Additional Vehicle Labor Requirements	$224,500
Operation and Maintenance Over Haul Distance	$811,200
Total Annual Cost	$1,253,300
Cost Per Ton	$32.10

f. Vasco Road

- Route Information

Round-Trip Miles	90
Average Driving Time Per Trip (hours)	1.77
Hours Remaining for Collection	6.23
Tons Collected Per Crew Per Day	5.61
Vehicles (Crews) Required	33
Spare Vehicles	3
Total Annual Miles	772,200

- Annual Route Costs

Amortization of Vehicles	$224,400
Additonal Vehicle Labor Requirements	$269,400
Operation and Maintenance Over Haul Distance	$965,300
Total Annual Cost	$1,459,100
Cost Per Ton	$37.40

g. <u>Altamont Pass</u>

- Route Information

Round-Trip Miles	94
Average Driving Time Per Trip (hours)	1.90
Hours Remaining for Collection	6.10
Tons Collected Per Crew Per Day	5.49
Vehicles (Crews) Required	33
Spare Vehicles	3
Total Annual Miles	806,520

- Annual Route Costs

Amortization of Vehicles	$217,600
Additional Vehicle Labor Requirements	$224,500
Operation and Maintenance Over Haul Distance	$1,008,200
Total Annual Cost	$1,450,300
Cost Per Ton	$37.20

B. TRANSFER AND HAUL

1. System Information

• Tons Currently Disposed of at Berkeley Landfill	250 tons/day*a
• Design Capacity (1.2)*b (250 tons/day)	300 tons/day
• Cost Per Transfer Vehicle Tractor (cab-over, three-axle 80,000# gvw,*c 15 foot wheelbase) Trailer (compactor design, 20 ton payload)	$80,000/ vehicle*d
• Amortization of Vehicle (8 years, 6%)	$12,000/year
• Spare Vehicles	
- if vehicles required number less than 10	1
- if vehicles required number less than 20, more than 10	2
• Average Vehicle Load Per Trip (90% of maximum, 20 tons)	18 tons/trip
• Vehicle Labor Cost - 1 Driver @ $10 per hour plus 26% benefits	$26,200/year
• Average Number of Trips Required (250 tons/day)/(18 tons/trip	14 trips/day*e
• Design Trips Required (300 tons/day)/(18 tons/trip)	17 trips/day*f
• Operation and Maintenance Cost of Transfer Vehicles	$7.30/hr.*g and $0.25/mile
• Average Working Hours	8 hrs./days
• Average Time Spent Per Trip Loading and Unloading Refuse	.7 hr./trip

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*a Five days per week, Reference 1.

*b Seasonal load factor.

*c Gross vehicle weight.

*d Cost includes 10% contingencies.

*e Used to determine operation and maintenance costs.

*f Used to determine vehicles required.

*g Cost estimates obtained from County of Sacramento.

2. Individual Route Costs (Sample calculations are provided for West Contra Costa County)

a. West Contra Costa County (Richmond)

- Route Information

Round-Trip Miles	24[*a]
Average Time Per Trip (.7 hrs./disposal/trip) + (.73 hrs./haul/trip)	1.43
Trips Per Vehicle Per 8-Hour Shift (8 hrs./day)/(1.43 hrs./trip)	5
Vehicles Required (17 trips/day)/(5 trip/day/vehicle)	4
Spare Vehicles (Required vehicles number less than 10)	1
Total Annual Miles (14 trips/day) (260 days/year) (24 mile/trip)	87,360
Total Annual Hours (14 trips/day)(260days/year)(1.43 hrs./trip)	5,205

- Annual Route Costs

Amortization of Vehicles (5 vehicles) ($12,900/vehicle/year)	$64,500
Vehicle Labor (4 drivers) ($26,200/year/driver)	$104,000
Operation and Maintenance ($7.30/hr.)(5,205 hrs./year) + ($0.24/mile)(87,360 miles/year)	$59,000
Total Annual Cost	$227,500
Cost Per Ton	$3.50

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*a From Second and Gilman Streets, Berkeley, to disposal site and return.

b. City of Alameda

- Route Information

Round-Trip Miles	26
Average Time Per Trip (hours)	1.30
Trips Per Vehicle Per 8-Hour Shift	6
Vehicle Required	3
Spare Vehicles	1
Total Annual Miles	94,640
Total Annual Hours	4,730

- Annual Route Costs

Amortization of Vehicles	$51,600
Vehicle Labor	$78,600
Operation and Maintenance	$57,200
Total Annual Cost	$187,400
Cost Per Ton	$2.90

c. Acme Fill

- Route Information

Round-Trip Miles	52
Average Time Per Trip (hours)	1.80
Trips Per Vehicle Per 8-Hour Shift	4
Vehicles Required	5
Spare Vehicles	1
Total Annual Miles	189,280
Total Annual Hours	6,550

- Annual Route Costs

Amortization of Vehicles	$77,400
Vehicle Labor	$131,000
Operation and Maintenance	$93,200
Total Annual Cost	$301,600
Cost Per Ton	$4.65

d. U. S. Steel (Pittsburgh)

- Route Information

Round-Trip Miles	78
Average Time Per Trip (hours)	2.10
Trips Per Vehicle Per 80-Hour Shift	3
Vehicles Required	6
Spare Vehicles	1
Total Annual Miles	283,920
Total Annual Hours	7,644

- Annual Route Costs

Amortization of Vehicle	$90,300
Vehicle Labor	$157,200
Operation and Maintenance	$123,900
Total Annual Cost	$371,400
Cost Per Ton	$5.70

e. Vasco Road

- Route Information

Round-Trip Miles	90
Average Time Per Trip (hours)	2.27
Trips Per Vehicle Per 8-Hour Shift	3
Vehicles Required	6
Spare Vehicles	1
Total Annual Miles	327,600
Total Annual Hours	8,262

- Annual Route Costs

Amortization of Vehicles	$90,300
Vehicle Labor	$157,200
Operation and Maintenance	$138,900
Total Annual Cost	$385,900
Cost Per Ton	$5.95

f. Altamont Pass

• Route Information

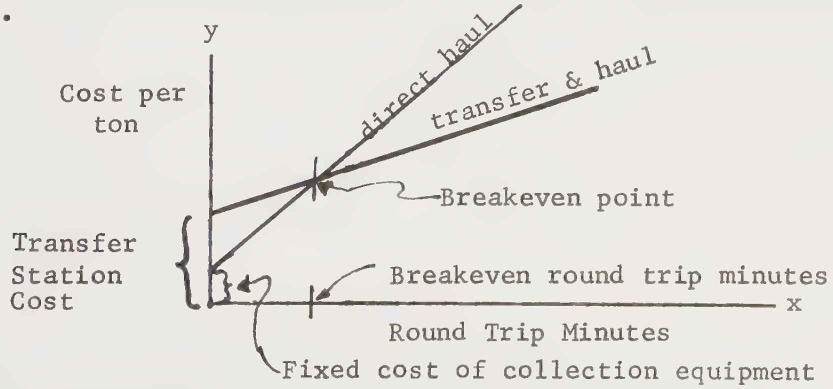
Round Trip Miles	94
Average Time Per Trip (hours)	2.40
Trips Per Vehicle Per 8-Hour Shift	3
Vehicles Required	6
Spare Vehicles	1
Total Annual Miles	342,160
Total Annual Hours	8,736

• Annual Route Costs

Amortization of Vehicles	$90,300
Vehicle Labor	$157,200
Operation and Maintenance	$145,900
Total Annual Cost	$393,400
Cost Per Ton	$6.05

C. BREAKEVEN ANALYSIS

Typically, if the location of the disposal site is more than 15 minutes (approximately 10 miles) from collection routes, transfer stations have been shown to be more economically attractive than direct haul (Reference 3). Using the information developed in this Appendix and Section B2, the breakeven time for Berkeley can be roughly calculated. The breakeven time is that time where the cost per ton for direct haul is equal to the cost for transfer and haul. Graphically, the breakeven point can be found at the point of intersection of the direct haul costs and the transfer and haul costs per round trip minutes as shown below.



Algebraically, the breakeven time can be found by solving the equations of the two lines. If the equation for a line is represented by

$$y = m x + b$$

where y = ordinate coordinate (y - direction)

m = slope of the line (cost/ton/minute)

x = abscissa coordinate (x - direction)

b = y - intercept

then, the line for direct haul and transfer and haul can be represented respectively as follows:

$$(y)_{\text{direct haul}} = (mx + b)_{\text{direct haul}}$$

$$(y)_{\text{transfer and haul}} = (mx + b)_{\text{transfer and haul}}$$

At the breakeven point,

$$(y)_{\text{direct haul}} = (y)_{\text{transfer and haul}}$$

Therefore,

$$(mx + b)_{\text{direct haul}} = (mx + b)_{\text{transfer and haul}}$$

If m and b are known for each, then x (the breakeven round-trip minutes) can be calculated

$$x = b_{TH} - b_{DH} / M_{DH} - M_{TH}$$

Based on the data obtained from this Appendix, the following two equations were obtained by linear regression

Direct Haul $y = .37x + 1.59$

Transfer Haul $y = .04x + 12.85$

Solving for x,

$$x \text{ (round-trip breakeven minutes)} = (12.85 - 1.59)/(.37 - .04$$
$$= 34 \text{ minutes}$$

In terms of costs per ton mile, the breakeven round trip mileage using the same procedure generated above, is 28.

APPENDIX F

ENERGY REQUIREMENTS FOR TRANSFER, HAUL AND DISPOSAL

APPENDIX F - ENERGY REQUIREMENTS FOR TRANSFER, HAUL AND DISPOSAL

F1 Energy Requirements at Transfer Station

Table F.1 lists the energy usage of the various types of equipment at the proposed transfer station.

The total energy consumption for the transfer station, 3.58×10^9 BTU per year is 55,000 BTU per ton for the 65,000 tons per year transferred. This figure was compared with two other studies. COR-met Engineers in their 1975 "Net Analysis, Metropolitan Service District Solid Waste Transfer/Processing System" projected 90,000 BTU per ton for a transfer station and Stanford Research Institute in their presentation of a study for P.G.&E., April 17, 1974 projected 36,000 BTU per ton. These other studies bracket the 55,000 BTU per ton estimated for Berkeley.

TABLE F.1

ENERGY REQUIREMENTS FOR TRANSFER STATION

Energy Consumption	Operation			
	Lighting & Miscellaneous	Electric Motors	Mobile Equipment	Total
Consumption by Operation	14,388 Watts	100 Horse Power	140 H.P. D6 Tractor 80 H.P. Loader	
Conversion Factor	3.4129 BTU/hr./watt	2.546 BTU/hr/H.P.	Tractor:5-6 gal diesel/hr* Loader:3-4 gal diesel/hr* 139,000 BTU/hr/gal	
Consumption BTU per Hour	$.049 \times 10^6$	$.255 \times 10^6$	1.25×10^6	
Hours of Operation per Day	10	8	8	
BTU per Day	$.491 \times 10^6$	2.04×10^6	10×10^6	12.53×10^6
BTU per Year (Based on 5-1/2 days/week)	$.140 \times 10^9$	$.583 \times 10^9$	2.36×10^9	3.58×10^9

Analysis of Fuel Consumption for Solid Waste Management, Appendix B, Office of Solid Waste Management, Environmental Protection Agency, January 1974.

F2 Energy Requirements for Transportation to Disposal Site

Sixty-five thousand tons of refuse would be transported in 20 ton capacity long haul trailers the 52 (round-trip) miles to Acme Fill Landfill with diesel tractors averaging 4.9 miles per gallon.* The total number of round-trip miles travelled is 189,280 miles per year (refer to Appendix E). The total energy required was calculated as follows:

189,280 miles per year/4.9 miles per gallon (139,000 BTU/gal diesel fuel*) = 5.36×10^9 BTU/year.

The energy required is then 82,500 BTU per ton. (5.36×10^9 BTU per year/ 65,000 ton per year).

This compares closely to the 62,500 BTU per ton in Marchant Wentworths, "Resource Recovery Truth and Consequences," Table A, Page 45, for haul.

F3 Energy Requirements at Disposal Site

There have been a number of studies which calculated the energy required to dispose of refuse at a sanitary landfill. The references and the BTU figure per ton is listed below:

- Wentworth: "Resource Recovery Truth and Consequences," Table A ..... 73,000 BTU/Ton
- COR-MET "Net Energy Analysis Metropolitan Service District Proposed Solid Waste Transfer/Processing Station," Calculated from Table 9 ..... 42,000 BTU/Ton
- Stanford Research Institute: Presentation of P.G.&E. study ..... 30,000 BTU/Ton

The COR-MET study presents their calculation in detail and as their figure is bracketed by the other two studies, the 42,000 BTU/Ton figure will be used here. The total energy required is then estimated to be:

(42,000 BTU/Ton)(65,000 Ton/year) = 2.73×10^9 BTU per year.

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* Analysis of Fuel Consumption for Solid Waste Management, Appendix B, Office of Solid Waste Management, Environmental Protection Agency, January 1974.

APPENDIX G

JUSTIFICATION FOR ELIMINATION
OF RESOURCE RECOVERY SYSTEMS
CONSIDERED INAPPROPRIATE -
STATE SOLID WASTE MANAGEMENT BOARD

STATE OF CALIFORNIA—THE RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

STATE SOLID WASTE MANAGEMENT BOARD
1020 NINTH STREET, SUITE 300
P.O. BOX 1743
SACRAMENTO, CALIFORNIA 95808

August 22, 1978

Mr. Michael D. Brown
Chief Environmental Engineer
Garretson, Elmendorf, Zinov & Reibin
Architects & Engineers
124 Spear Street
San Francisco, CA 94105

Dear Mr. Brown:

FILE 1562		
FOR	COPY	ENCL
A		
C/S		
M		
E		
ENV	✓	
Bdg	✓	
By	JD	

In the work which you are currently doing for the City of Berkeley, one of your first tasks was to identify numerous alternative resource recovery schemes and to screen these preliminary alternatives to eliminate those which are not promising. The reason for the screening was to narrow down the scope of work by eliminating the nonproductive work of evaluating alternatives which would later be rejected.

The initial screening was done at a meeting between staff of the Solid Waste Management Board, representatives of the City of Berkeley, and staff of Garretson, Elmendorf, Zinov, and Reibin. This letter will summarize the conclusions reached at the screening meeting.

The alternatives eliminated and the reasons for the elimination are as follows:

1. Methanol, Ethanol, Ammonia, and Hydrogen Syntheses were eliminated because several studies so far have shown that the economics of these processes require large systems of at least 1,000 ton per day capacity.

2. Pyrolysis. The pyrolysis systems of Occidental, Monsanto, Purox, and Deco were eliminated because Occidental, Monsanto and Deco have yet to demonstrate reliable operation. Purox was eliminated because it requires a larger system that is possible in Berkeley, and because all present estimates have shown Purox to be uneconomical in nearly any size considered.

3. Fluid bed combustion such as the CPU system was eliminated because the CPU system has not been successfully demonstrated. Problems with gas clean up and the resulting inability to operate a gas turbine.

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GARRETSON - ELMENDORF - ZINOV ...

4. Composting was conditionally eliminated. Although it is a demonstrated technology, there is not a demonstrated market for the compost in the quantities that would be produced by composting 200 tons a day.

5. There are several incinerator systems which are not necessary to investigate at this time. One of these is the Black Clawson System which is currently being demonstrated. Another is the Hoskinson Auger Combustor, which has been demonstrated on a small scale in Florida. Even though this system is probably adequate, it is too developmental for inclusion in this study. The O'Connor Rotary Combustor may be disregarded also as it has not operated in this country. However, it is operating in Japan and if adequate data can be obtained, it might be worthwhile to include in the study.

6. There are several biological processes which do not warrent inclusion in this study, as follows:

   Bio-gasification should not be included. This technique is currently in a large scale developmental process in Pompano Beach, Florida. Enzyme conversion of waste to protein is still in the early developmental stage, is not ready for commercial operation, and therefore should not be included. The same can be said for using earthworms to convert waste.

   Fermenting waste to produce ethanol may be usable, but we have no information on any large scale system using this process except for a general description from Bolivia.

If there are any errors or omissions in the above summary, please let me know so that I may make any necessary correction. You can contact me at (916) 322-1442.

Sincerely,

B. Robert Harper

B. Robert Harper
Waste Management Engineer

APPENDIX H

ECONOMIC IMPACT OF SOURCE SEPARATION ON LEAST COST SYSTEM

APPENDIX H

ECONOMIC IMPACT OF SOURCE SEPARATION ON LEAST COST SYSTEM*a

A. Revenue Impact

1. Total energy in refuse without source separation =

   (64,400 tons MSW/yr.) x (9×10^6 Btu/ton) = 58.0×10^{10} Btu/yr.

2. Energy loss due to removal of paper products =

   a. (2,055 tons cardboard/yr.) x (14.1×10^6 Btu/ton) = 2.9×10^{10} Btu/yr.

   b. (2,800 tons newspaper/yr.) x (15.9×10^6 Btu/ton) = 4.5×10^{10} Btu/yr.

   c. (715 tons mixed paper/yr.) x (15.6×10^6 Btu/ton) = 1.1×10^{10} Btu/yr.

   Total loss (2a + 2b + 2c) = 8.5×10^{10} Btu/yr.

3. Energy reduction factor due to source separation =

$$\frac{58.0 \times 10^{10} - 8.5 \times 10^{10}}{58.0 \times 10^{10}} = .85$$

4. Steam revenue without source separation = $940,000/yr. (refer to Table D5-1)

5. Steam revenue with source separation = $940,000 x .85 = $799,000

6. Cardboard revenue with source separation =

   (4,200 - 2,055) x .25 x $12 = $6,000

7. Total revenue with source separation = $799,000 + $6,000 = $805,000

B. Operating Cost Impact

1. Operating cost of Package Incinerators = $960,000

2. Operating cost with source separation =

$$\$960,000 \times \frac{54,865^{*b}}{64,400} = \$816,000$$

*a Based on 60 percent residential and 50 percent commercial participation in a Curbside Collection Program and the operation of a City-wide Recycling Center as established in Reference 1.

*b Refer to Table A-1.

C. Total Annual Net Cost With Source Separation

1.	Fixed Annual Cost of Package Incinerators	\$580,000
2.	Adjusted Revenue	\$805,000
3.	Adjusted Annual Operating Cost	\$816,000
4.	Net Annual Cost of Recycling Center*c	\$ 18,000
5.	Net Annual Cost of Curbside Collection Program and Storage Depot*c	\$260,000
	Total Annual Net Cost (1-2 + 3 + 4 + 5) =	\$869,000

D. Additional Annual Cost of Incorporating Source Separation

\$869,000 - \$585,000 = \$284,000 (or \$4 per incoming ton)

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*c Reference 1 escalated 10 percent to mid 1978.